MACHINERY.

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SETTING-ANGLES FOR MILLING ANGULAR CUTTERS AND TAPER REAMERS.*

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IN the calculation of setting-angles for angular cutters, end mills, taper reamers, and the like, the number of angles involved usually makes the calculations difficult and uncertain, and, as a general thing, the settings can be obtained by the cut-and-try method in less time than it takes to compute them. It is a great satisfaction, however, to be able to give a workman a blank for angular cutters with full data as to angles of elevation, set-over, or other adjustments required. In some cases, especially where the calculations can be carried out in the drafting-room, time can be saved, all guesswork eliminated, and data for the settings put on the drawing the same as other dimensions. In the case of an angular cutter the problem may be stated as follows:

Given a milling cutter blank of any angle β, to have any number of teeth n to be cut with a single angle cutter of any angle ϕ, to find the angle of elevation of index-head, so that when teeth are cut, the lands shall be of equal width throughout their length.

Fig. 1 represents a side and end view of the blank, and Fig. 2 the index head adjusted to the proper angle for the blank under consideration.

Let r = radius of blank,

n = the number of teeth,

β = the angle of blank,

ϕ = angle of cutter,

$$\theta = \text{tooth angle} = \frac{360}{n},$$

γ and δ angles, as shown in Fig. 1.

In Fig. 1, the line OA is the axis of a cone which would result from prolonging the blank down to a point. The line OC is the intersection of the two planes which form the sides of the tooth space, and hence the cutter must run parallel to this line while cutting a space. The head must then be elevated so that the line OC is parallel with the table, and in doing so we will have turned it through an angle equal to AOC, or α. Line EF is drawn perpendicular to OC. From the figure then,

$$\tan\alpha = \frac{AD}{AO}.$$

But $AD = AB - BD$, and $BD = BC \sec\alpha$.

Therefore $AD = AB - BC \sec\alpha$.

But $AB = r\cos\theta$; $BC = r\sin\theta\cot\phi$; and $AO = r\tan\beta$.

$$\text{Therefore } \tan\alpha = \frac{r\cos\theta - r\sin\theta\cot\phi\sec\alpha}{r\tan\beta} \qquad (1)$$

For convenience of calculation let $\tan\beta = x$; $\cos\theta = y$; $\sin\theta\cot\phi = z$. Cancelling out the r's and making these substitutions transforms equation (1) to

$$\tan\alpha = \frac{y - z\sec\alpha}{x}$$

$$\text{or } x\tan\alpha = y - z\sec\alpha$$

Substituting the sine and cosine for the tangent and secant, we have:

$$\frac{x\sin\alpha}{\cos\alpha} = y - \frac{z}{\cos\alpha}$$

$$\text{Squaring this gives: } \frac{x^2\sin^2\alpha}{\cos^2\alpha} = y^2 - \frac{2yz}{\cos\alpha} + \frac{z^2}{\cos^2\alpha}.$$

$$x^2\sin^2\alpha = y^2\cos^2\alpha - 2yz\cos\alpha + z^2.$$

Substituting in terms of cosine gives $x^2 - x^2\cos^2\alpha = y^2\cos^2\alpha$

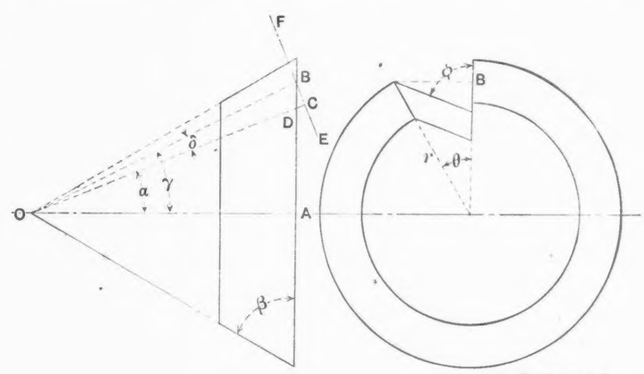

Fig. 1. Diagram for Calculating Setting-angle for Angular Cutters.

$-2yz\cos\alpha + z^2$, or $(x^2 + y^2)\cos^2\alpha - 2yz\cos\alpha + z^2 - x^2 = 0$. from which

$$\cos\alpha = \frac{yz}{x^2 + y^2} \pm \sqrt{\frac{y^2z^2}{(x^2+y^2)^2} - \frac{z^2 - x^2}{x^2 + y^2}}$$

or, finally,

$$\cos\alpha = \frac{yz \pm x\sqrt{x^2 + y^2 - z^2}}{x^2 + y^2}$$

where $x = \tan\beta$; $y = \cos\theta$; and $z = \sin\theta\cot\phi$.

It will be observed that this is a very unwieldy and difficult equation to handle and we can arrive at a much easier solution by introducing the auxiliary angles γ and δ, the difference of which is the angle desired. In other words, by dividing the problem into two parts, we can obtain comparatively simple expressions for γ and δ, and a simple subtraction then gives α. The angle AOB or γ, Fig. 1, would be the angle of elevation if we were cutting the blank with a 90-degree cutter. In this case δ would disappear and $\gamma = \alpha$. From the figure,

$$\tan\gamma = \frac{AB}{AO}; \text{ but } AB = r\cos\theta; \text{ and } AO = r\tan\beta.$$

$$\text{Therefore } \tan\gamma = \frac{\cos\theta}{\tan\beta} \qquad (2)$$

$$\text{Also } \sin\delta = \frac{BC}{OB}; \text{ but } BC = r\sin\theta\cot\phi; \text{ and } OB = \frac{r\cos\theta}{\sin\gamma}.$$

* For previous articles on this and related subjects see: "To Calculate the Setting of the Dividing Head when Cutting the Teeth of End Mills," by George G. Porter, April, 1904, and "Formulas for Milling End Mills and Clutches," by Irving Banwell, February, 1908.

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‡ W. A. Knight was born in Delaware County, Ohio, 1864, and received a grammar school education. In 1880 he entered the employ of the Novelty Iron Works, and after serving three years in that shop went to the A. R. Rarig Co., general founders and machinists. Later he was with Royce & Pulling Steam Pump Co., erecting pipe work and shafting, overhauling engines and doing general repair work. In 1885 he was made stationary engineer for the Union Passenger Station, Columbus, Ohio, and continued in that capacity until 1887. During the three years he filled this position he became greatly interested in physics and general science and acquired a strong desire for a technical education. Leaving the position, he associated with H. P. Minot (who had worked for twenty years in the shop of the Putnam Machine Co., Fitchburg, Mass.), overhauling engines, taking indicator diagrams, etc. A 20-light dynamo was built for lighting the shop, this being one of the early lighting machines constructed. The building of this machine led to the organization of the Minot Electric and Machine Co., of which Mr. Knight was foreman and electrician. Upon the dissolution of the company in 1892 following the death of Mr. Minot, Mr. Knight obtained employment with the Jeffrey Mfg. Co., and in 1893 obtained a position at the Ohio State University as assistant in industrial arts and foreman of the machine shop. Later he became an instructor in machine work and graduated from the institution in 1900 with a degree of mechanical engineer.

Therefore $\sin\delta = \dfrac{\dfrac{r\sin\theta\cot\phi}{r\cos\theta}}{\sin\gamma}$

or $\sin\delta = \tan\theta\cot\phi\sin\gamma$. (3)

With equations (2) and (3) we can find the value of γ and δ, and their difference is the angle of elevation.

For $\beta = 0$ (case of an end mill, teeth on the end) equation (2) becomes $\tan\gamma = \dfrac{\cos\theta}{0}$, or $\tan\gamma$ is infinite, from which $\gamma = 90°$. Substituting sin 90 for $\sin\gamma$ in (3) gives $\sin\delta = \tan\theta\cot\phi$. But $\alpha = \gamma - \delta = 90 - \delta$, or $\cos\alpha = \cos(90 - \delta) = \sin\delta$, and since $\sin\delta = \tan\theta\cot\phi$ we have, finally, for the end mill,

$$\cos\alpha = \tan\theta\cot\phi \quad (4)$$

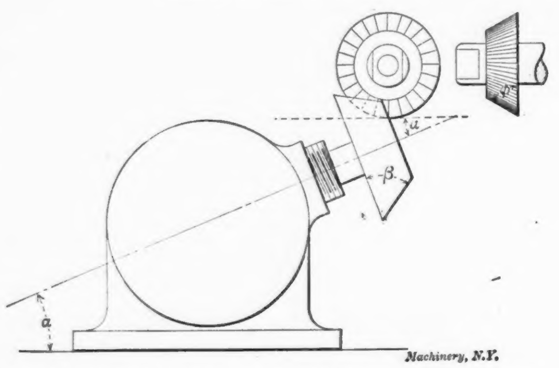


Fig. 2. Diagram of Head, Blank, and Cutter for Milling Teeth.

This is the same equation given in MACHINERY, April, 1904, by Mr. George G. Porter, and is a special case of the more general equation.

In this solution, and in the final equations, the width of land does not appear. The teeth of the cutter are considered as being cut to a sharp point; that is, without lands. This is done to simplify the mathematical work, and in no wise affects the results. It can be shown mathematically that the angle of elevation, when teeth are cut with a single angle cutter, is independent of both the width of land and radius of blank. The solution is therefore of general application. With the proper angle of elevation we can make the width of lands anything we choose, and they will be of equal width *after being backed off for clearance.*

Example: A 70-degree milling cutter blank is to have 18 teeth, and to be cut with a 65-degree single angle cutter. What will be the angle of elevation of the index head?

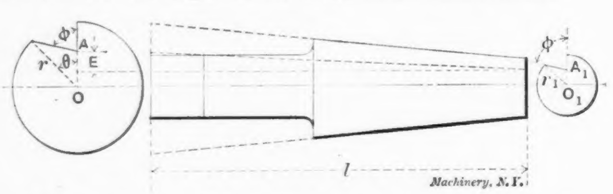


Fig. 3. Diagram for Calculating Setting Angle for Taper Reamer.

In this example $n = 18$; $\beta = 70$ degrees; $\phi = 65$ degrees; $\theta = \dfrac{360}{18} = 20$ degrees.

The work would be carried out thus:

log cos 20 deg. $= \bar{1}.97299$
log tan 70 deg. $= 0.43893$

log tan γ $= \bar{1}.53406$
from which γ = 18 degrees 53 minutes.
log tan 20 deg. $= \bar{1}.56107$
log cot 65 deg. $= \bar{1}.66867$
log sin 18 deg. 53 min. $= \bar{1}.51007$

log sin δ $= \bar{2}.73981$
from which δ = 3 degrees 9 minutes.

$\alpha = \gamma - \delta = 18$ deg. 53 min. $- 3$ deg. 9 min. $= 15$ deg. 44 min.

The angle of elevation is therefore 15 degrees 44 minutes.

Taper Reamer Held on Centers.

In the case of a taper reamer held on centers, we wish to know how much the tail center should be elevated above the live center so that the cut shall be of correct depth at each end of the reamer. The taper per foot could be converted into degrees, and the formulas in the preceding part of this article used to determine the angle of elevation from which the elevation could readily be found; but it is more convenient to work with the taper per foot, and, proceeding as follows, we can find an expression for the elevation in terms of this taper.

[Attention should, however, be called to the fact that the formula deduced below is only approximately correct, although the error involved is so small that for all ordinary tapers, say up to one inch per foot, the difference is not of any account for practical purposes. As will be seen, the elevation of the tail center is assumed to be $OA - O_1A_1$ (see Fig. 3). The true elevation, however, is $(OA - O_1A_1)\cos v$, if v be the angle between the axis of the work and the bottom of the reamer flute. The cosine for small angles is so near unity that the difference becomes of no account. For a reamer with ¾-inch taper per foot, for instance, cos v would become 0.9995. On account of the small angle between the plane in which angle θ and angle ϕ are measured, they have been considered to be in the same plane, in order to give a more convenient formula for calculation. It should be remembered, however, that to do so is permissible only in the case of reamers with a comparatively slignt taper, and that the formulas below should not be used for reamers of abnormally large tapers. For such reamers the formula for angular milling cutters should be employed, which formula is mathematically correct.—EDITOR.]

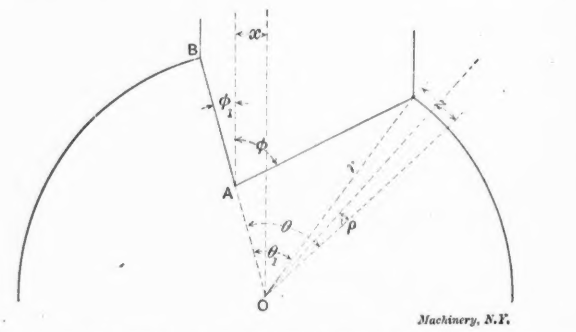


Fig. 4. Double-angle Cutter for Milling Straight Reamer Flutes.

As before, let

n = number of teeth,
ϕ = angle of cutter,
θ = tooth angle $= \dfrac{360}{n}$,
T = taper per foot,
l = total length of reamer, or distance between centers, in inches,
E = elevation of tail center.

From Fig. 3, $E = OA - O_1A_1$

$$OA = r\cos\theta - r\sin\theta\cot\phi;$$
$$O_1A_1 = r_1\cos\theta - r_1\sin\theta\cot\phi, \text{ and}$$
$$E = (r - r_1)(\cos\theta - \sin\theta\cot\phi),$$

But $(r - r_1) = \dfrac{Tl}{12 \times 2}$;

Therefore $E = \dfrac{Tl}{12 \times 2}(\cos\theta - \sin\theta\cot\phi)$. (5)

Example: A taper reamer is to have 6 teeth, a taper of ¾ inch per foot, is 8 inches long and is to be cut with an 80-degree cutter. How much should tail center be elevated?

In this case $\theta = \dfrac{360}{6}$, or 60 degrees, and $\phi = 80$ degrees.

Then $E = \dfrac{0.75 \times 8}{12 \times 2}(0.5 - 0.866 \times 0.176) = 0.087$, or elevation $= 0.087$ inch.

Case of the Double-angle Cutter.

The use of a double angle cutter for grooving a taper reamer or angular mill adds several complications to the setting of the machine, not met with when using single angle

ANGLES OF ELEVATION FOR END MILLS.

Number of Teeth.	Angle of Cutter.							
	85	80	75	70	65	60	55	50
5	74°23′	57° 8′	34°27′	......	......	......	......	......
6	81 17	72 13	62 21	50°55′	36° 8′	......	......	......
7	83 42	77 13	70 22	62 50	54 12	43°36′	......	......
8	84 59	79 51	74 27	68 39	62 12	54 44	44°27′	32°57′
9	85 47	81 29	77 0	72 13	66 58	61 1	54 1	45 15
10	86 21	82 38	78 46	74 40	70 12	65 12	59 25	52 26
11	86 47	83 29	80 5	76 28	72 34	68 13	63 15	57 22
12	87 6	84 9	81 6	77 52	74 23	70 32	66 9	61 2
13	87 22	84 41	81 54	78 59	75 48	72 21	68 26	63 52
14	87 35	85 8	82 35	79 54	77 1	73 51	70 17	66 10
15	87 46	85 30	83 9	80 40	78 1	75 6	71 50	68 4
16	87 55	85 49	83 38	81 20	78 52	76 10	73 8	69 40
17	88 3	86 5	84 3	81 53	79 36	77 4	74 15	71 1
18	88 11	86 19	84 24	82 23	80 14	77 52	75 14	72 13
19	88 17	86 32	84 43	82 49	80 47	78 34	76 6	73 15
20	88 22	86 43	85 0	83 13	81 17	79 11	76 51	74 11
21	88 27	86 53	85 15	83 33	81 44	79 44	77 31	74 59
22	88 32	87 2	85 29	83 52	82 8	80 14	78 8	75 44
23	88 36	87 10	85 42	84 9	82 30	80 42	78 41	76 24
24	88 39	87 18	85 53	84 24	82 49	81 6	79 11	77 0

ANGLES OF ELEVATION FOR 15 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	49° 4′	37° 3′	24°52′	10°32′	......	......	......	......	......
6	61 49	54 9	46 12	37 40	28° 4′	16°26′	......	......	......
7	66 44	60 57	55 1	48 45	41 57	34 14	25° 2′	12°57′	......
8	69 15	64 33	59 46	54 44	49 21	43 24	36 34	28 21	17°34′
9	70 43	66 45	62 41	58 28	53 58	49 3	43 30	37 2	29 4
10	71 40	68 12	64 41	61 1	57 8	52 55	48 12	42 47	36 18
11	72 20	69 16	66 8	62 54	59 27	55 44	51 37	46 56	41 24
12	72 48	70 2	67 13	64 18	61 13	57 54	54 14	50 5	45 13
13	73 10	70 39	68 5	65 26	62 38	59 37	56 18	52 34	48 14
14	73 26	71 7	68 46	66 20	63 46	61 0	57 59	54 35	50 38
15	73 39	71 30	69 20	67 5	64 42	62 10	59 22	56 15	52 39
16	73 50	71 50	69 49	67 43	65 30	63 9	60 33	57 40	54 20
17	73 58	72 6	70 12	68 14	66 11	63 58	61 33	58 51	55 46
18	74 5	72 20	70 33	68 42	66 46	64 41	62 26	59 54	57 0
19	74 11	72 32	70 51	69 6	67 17	65 19	63 11	60 49	58 6
20	74 16	72 42	71 6	69 28	67 44	65 53	63 52	61 37	59 3
21	74 20	72 51	71 20	69 46	68 7	66 22	64 27	62 20	59 54
22	74 24	72 59	71 32	70 3	68 29	66 49	65 0	62 59	60 40
23	74 27	73 6	71 43	70 18	68 49	67 13	65 29	63 33	61 22
24	74 30	73 12	71 53	70 32	69 6	67 35	65 56	64 5	61 59

ANGLES OF ELEVATION FOR 5 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	74°12	59°11′	42°43′	21°41′	......	......	......	......	......
6	80 4	71 29	62 34	53 52	41°41′	27°22′	......	......	......
7	82 1	75 47	69 22	62 35	55 9	46 33	36°12′	21°36′	......
8	82 57	77 58	72 52	67 32	61 47	55 23	48 0	38 56	25°40′
9	83 29	79 18	75 2	70 35	65 49	60 36	54 43	47 46	38 30
10	83 50	80 13	76 31	72 41	68 35	64 9	59 11	53 27	46 4
11	84 4	80 52	77 36	74 12	70 37	66 43	62 24	57 28	51 15
12	84 14	81 21	78 25	75 23	72 10	68 42	64 52	60 31	55 5
13	84 21	81 44	79 4	76 13	73 23	70 15	66 48	62 54	58 4
14	84 27	82 3	79 36	77 4	74 24	71 32	68 23	64 50	60 28
15	84 32	82 19	80 3	77 43	75 15	72 30	69 42	66 27	62 28
16	84 35	82 31	80 25	78 14	75 57	73 30	70 49	67 48	64 7
17	84 38	82 42	80 44	78 42	76 34	74 16	71 46	68 58	65 33
18	84 41	82 52	81 1	79 7	77 6	74 57	72 36	69 59	66 47
19	84 43	83 0	81 16	79 28	77 34	75 33	73 20	70 52	67 42
20	84 45	83 8	81 29	79 47	77 59	76 4	73 59	71 39	68 50
21	84 46	83 14	81 40	80 3	77 21	76 32	74 33	72 20	69 40
22	84 47	83 19	81 50	80 17	78 40	76 57	75 4	72 58	70 26
23	84 48	83 24	81 59	80 30	78 58	77 20	75 32	73 32	71 7
24	84 49	83 29	82 7	80 43	79 15	77 40	75 57	74 3	71 44

ANGLES OF ELEVATION FOR 20 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	40°20′	30° 4′	19°46′	8° 4′	......	......	......	......	......
6	53 57	46 55	39 39	31 55	23°18′	13°11′	......	......	......
7	59 43	54 17	48 42	42 51	36 30	29 23	21° 1′	10°23′	......
8	62 46	58 18	53 45	48 59	43 53	38 16	31 53	24 16	14°31′
9	64 35	60 47	56 54	52 52	48 34	43 53	38 38	32 32	25 5
10	65 47	62 28	59 4	55 33	51 50	47 47	43 18	38 9	32 1
11	66 36	63 39	60 38	57 30	54 12	50 38	46 11	42 12	36 56
12	67 12	64 32	61 49	59 0	56 2	52 50	49 18	45 19	40 40
13	67 39	65 13	62 44	60 11	57 28	54 34	51 22	47 47	43 36
14	68 0	65 46	63 29	61 8	58 39	55 59	53 4	49 47	46 0
15	68 17	66 13	64 6	61 55	59 38	57 10	54 28	51 27	47 58
16	68 30	66 34	64 36	62 34	60 26	58 9	55 39	52 51	49 38
17	68 41	66 53	65 2	63 8	61 8	59 0	56 40	54 3	51 4
18	68 50	67 8	65 24	63 37	61 44	59 44	57 32	55 5	52 17
19	68 57	67 21	65 43	64 2	62 15	60 22	58 18	55 59	53 21
20	69 3	67 32	65 59	64 23	62 43	60 55	58 58	56 47	54 18
21	69 9	67 42	66 14	64 42	63 8	61 25	59 34	57 30	55 9
22	69 14	67 51	66 28	64 59	63 30	61 52	60 7	58 9	55 55
23	69 18	67 59	66 39	65 15	63 50	62 16	60 36	58 44	56 36
24	69 21	68 5	66 49	65 30	64 7	62 38	61 2	59 14	57 12

ANGLES OF ELEVATION FOR 10 DEGREE BLANK.

Number of Teeth	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	60°16′	46°45′	32° 9′	14°31′	......	......	......	......	......
6	70 34	62 11	53 50	44 37	34° 5′	20°57′	......	......	......
7	74 12	68 8	61 55	55 20	48 9	39 57	30° 2′	16°32′	......
8	76 0	71 8	66 9	60 56	55 19	49 6	41 56	33 12	20°39′
9	77 2	72 56	68 45	64 23	59 21	54 7	48 52	42 6	33 8
10	77 42	74 8	70 31	66 44	62 44	57 22	53 30	47 54	40 42
11	78 10	75 1	71 48	68 28	64 56	61 6	56 52	52 2	45 56
12	78 30	75 40	72 46	69 47	66 37	63 12	59 26	55 10	49 50
13	78 44	76 9	73 31	70 48	67 56	64 51	61 26	57 36	52 51
14	78 56	76 34	74 9	71 39	69 2	66 12	63 6	59 36	55 19
15	79 5	76 54	74 40	72 21	69 56	67 19	64 28	61 15	57 20
16	79 12	77 10	75 5	72 57	70 41	68 16	65 37	62 39	59 1
17	79 18	77 23	75 27	73 27	71 20	69 4	66 36	63 51	60 28
18	79 22	77 34	75 45	73 52	71 53	69 46	67 27	64 58	61 43
19	79 26	77 44	76 1	74 15	72 23	70 23	68 12	65 46	62 48
20	79 30	77 54	76 16	74 35	72 44	70 56	68 52	66 34	63 47
21	79 33	78 2	76 29	74 53	73 12	71 25	69 28	67 17	64 38
22	79 35	78 8	76 40	75 9	73 33	71 51	69 59	67 55	65 25
23	79 37	78 18	76 50	75 23	73 52	72 14	70 28	68 29	66 6
24	79 39	78 20	76 59	75 30	74 9	72 35	70 54	69 1	66 44

ANGLES OF ELEVATION FOR 25 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	33°32′	25° 0′	16° 5′	6° 27′	......	......	......	......	......
6	47 0	40 38	34 6	27 10	19°33′	10°48′	......	......	......
7	53 12	48 10	43 0	37 35	31 43	25 17	17°44′	8°31′	......
8	56 36	52 25	48 8	43 40	38 55	33 41	27 47	20°50	11°33′
9	58 40	55 4	51 24	47 36	43 33	39 8	34 13	28 33	21 15
10	60 2	56 53	53 40	50 21	46 47	42 58	38 43	32 53	27 47
11	61 0	58 11	55 18	52 20	49 12	45 48	42 4	37 49	32 32
12	61 42	59 9	56 33	53 52	51 2	47 59	44 38	40 51	36 10
13	62 14	59 54	57 32	55 5	52 30	49 44	46 41	43 15	39 2
14	62 38	60 29	58 19	56 3	53 41	51 8	48 20	45 12	41 22
15	62 57	61 0	58 57	56 52	54 39	52 18	49 43	46 50	43 18
16	63 13	61 22	59 29	57 32	55 29	53 17	50 53	48 13	44 57
17	63 26	61 42	59 54	58 6	56 11	54 8	51 54	49 23	46 21
18	63 37	61 59	60 19	58 36	56 48	54 52	52 46	50 25	47 34
19	63 46	62 13	60 38	51 1	57 20	55 30	53 31	51 19	48 38
20	63 53	62 25	60 56	59 23	57 47	56 4	54 11	52 6	49 33
21	63 59	62 36	61 11	59 43	58 11	56 34	54 47	52 48	50 23
22	64 5	62 46	61 25	60 1	58 34	57 1	55 19	53 26	51 9
23	64 10	62 55	61 37	60 17	58 54	57 25	55 48	54 0	51 50
24	64 14	63 3	61 47	60 31	59 12	57 46	56 13	54 30	52 26

cutters. In the first place the center must be offset a certain distance so that when the cutter is sunk into the blank the proper depth, the faces of teeth will be radial. Secondly, the reamer or mill must be turned through a horizontal angle as well as a vertical one in order that the plane of the face of the teeth shall pass through the center or axis of the cone. Stated differently, the cutting edge should be an element of the cone, and since the offset distance is different for the large and small ends of the reamer, to adjust for this, the tail-center must be set over a distance equal to the difference of these values. Thirdly, the radius and width of land must be taken into account. And fourthly, the expressions for the angle of elevation are altogether more complicated, so much so in fact as to be of little practical value.

ANGLES OF ELEVATION FOR 30 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	28° 9′	20°51′	13°17	......	......	......	......	......	......
6	40 54	35 12	29 22	23°13′	16°32′	8°59′	.....	......	......
7	47 12	42 35	37 52	32 56	27 38	21 47	15° 6′	7° 5′	......
8	50 46	46 53	42 55	38 47	34 24	29 36	24 12	17 55	10°14′
9	53 0	49 38	46 13	42 40	38 53	34 48	30 14	25 1	18 47
10	54 29	51 31	48 30	45 22	42 3	38 29	34 31	30 1	24 44
11	55 32	52 52	50 10	47 22	44 25	41 13	37 43	33 45	29 8
12	56 18	53 53	51 26	48 54	46 14	43 21	40 12	36 38	32 32
13	56 54	54 42	52 27	50 8	47 41	45 4	42 12	38 58	35 15
14	57 21	55 19	53 15	51 7	48 52	46 27	43 49	40 51	37 27
15	57 42	55 49	53 54	51 55	49 50	47 35	45 9	42 25	39 17
16	58 0	56 14	54 27	52 36	50 39	48 34	46 19	43 47	40 52
17	58 14	56 35	54 54	53 10	51 21	49 24	47 17	44 55	42 12
18	58 26	56 53	55 18	53 40	51 57	50 7	48 7	45 53	43 20
19	58 36	57 8	55 38	54 6	52 29	50 45	48 51	46 46	44 22
20	58 44	57 21	55 55	54 28	52 56	51 18	49 30	47 31	45 15
21	58 51	57 32	56 10	54 47	53 20	51 47	50 5	48 12	46 3
22	58 57	57 42	56 24	55 5	53 42	52 13	50 36	44 48	46 46
23	59 3	57 51	56 37	55 21	54 2	52 37	51 4	49 21	47 25
24	59 8	57 59	56 48	55 36	54 20	52 59	51 30	49 52	48 0

ANGLES OF ELEVATION FOR 45 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	17°10′	12°36′	7°57′	3° 5′	......	......	......	......	......
6	26 34	22 41	18 43	14 35	10°11′	5°23′	......	......	......
7	31 56	28 36	25 13	21 42	17 56	13 55	9°24′	4°15′	......
8	35 16	32 22	29 25	26 22	23 8	19 39	15 48	11 25	5°58′
9	37 27	34 54	32 17	29 36	26 45	23 41	20 19	16 31	11 49
10	38 58	36 41	34 21	31 57	29 24	26 40	23 40	20 18	16 10
11	40 4	38 0	35 53	33 42	31 24	28 57	26 15	23 14	19 32
12	40 54	39 0	37 5	35 5	33 0	30 45	28 18	25 33	22 13
13	41 32	39 47	38 1	36 11	34 15	32 12	29 57	27 36	24 23
14	42 1	40 24	38 46	37 4	35 17	33 22	31 18	28 58	26 9
15	42 25	40 55	39 23	37 48	36 9	34 22	32 26	30 17	27 40
16	42 44	41 20	39 54	38 25	36 52	35 12	33 24	31 23	28 57
17	43 0	41 41	40 20	38 57	37 29	35 55	34 14	32 20	30 4
18	43 13	41 58	40 42	39 24	38 1	36 33	34 56	33 10	31 1
19	43 24	42 13	41 1	39 47	38 28	37 5	35 34	33 54	31 51
20	43 34	42 26	41 18	40 8	38 53	37 34	36 8	34 33	32 37
21	43 42	42 37	41 33	40 26	39 15	38 0	36 38	35 7	33 17
22	43 49	42 47	41 46	40 42	39 34	38 23	37 5	35 38	34 53
23	43 55	42 56	41 57	40 56	39 52	38 43	37 29	36 6	35 26
24	44 0	43 4	42 7	41 9	40 7	39 1	37 50	36 31	35 55

ANGLES OF ELEVATION FOR 35 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	23°49′	17°35′	11°10′	4°22′	......	......	......	......	......
6	35 32	30 29	25 19	19 53	14° 3′	7° 1′	......	......	......
7	41 41	37 20	33 14	28 46	24 1	18 48	12°54′	5°58′	......
8	45 17	41 43	38 5	34 19	30 18	25 56	21 4	15 27	8°41′
9	47 34	44 28	41 18	38 1	34 32	30 47	26 37	21 52	16 16
10	49 7	46 22	43 33	40 39	37 35	34 17	30 38	26 30	21 40
11	50 14	47 46	45 14	42 38	39 53	36 55	33 40	30 0	25 44
12	51 3	48 48	46 30	44 8	41 39	38 58	36 2	32 44	28 55
13	51 40	49 36	47 30	45 20	43 3	40 36	37 55	34 55	31 28
14	52 9	50 15	48 19	46 18	44 12	41 57	39 28	36 42	33 33
15	52 32	50 46	48 58	47 6	45 9	43 4	40 46	38 12	35 17
16	52 50	51 11	49 20	47 46	45 56	43 59	41 51	39 28	36 45
17	53 5	51 32	49 57	48 20	46 37	44 47	42 47	40 33	38 1
18	53 18	51 50	50 21	48 49	47 12	45 29	43 36	41 31	39 8
19	53 29	52 6	50 42	49 14	47 43	46 5	44 19	42 21	40 6
20	53 38	52 19	50 59	49 36	48 10	46 37	44 57	43 5	40 57
21	53 46	52 31	51 15	49 56	48 34	47 6	45 31	43 44	41 43
22	53 53	52 42	51 29	50 14	48 56	47 32	46 1	44 19	42 24
23	53 59	52 51	51 42	50 30	49 15	47 55	46 28	44 51	43 1
24	54 4	52 59	51 53	50 44	49 32	48 16	46 52	45 20	43 35

ANGLES OF ELEVATION FOR 50 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	14°32′	10°39′	6°42′	2°33′	......	......	......	......	......
6	22 45	19 23	15 58	12 24	8°38′	4°32′	......	......	......
7	27 37	24 42	21 44	18 39	15 24	11 54	8° 1′	3°36′	......
8	30 41	28 8	25 31	22 50	19 59	16 55	18 33	9 45	5°20′
9	32 44	30 28	28 9	25 45	23 14	20 31	17 32	14 13	10 22
10	34 10	32 7	30 2	27 54	25 39	23 12	20 32	17 34	14 9
11	35 13	33 22	31 28	29 31	27 28	25 16	22 52	20 11	17 6
12	36 0	34 18	32 34	30 47	28 53	26 54	24 42	22 15	19 27
13	36 36	35 2	33 26	31 48	30 3	28 13	26 11	23 56	21 22
14	37 5	35 38	34 9	32 47	31 1	29 18	27 26	25 21	22 58
15	37 28	36 7	34 44	33 18	31 49	30 13	28 28	26 32	24 20
16	37 47	36 31	35 13	33 53	32 29	31 0	29 22	27 33	25 30
17	38 2	36 50	35 37	34 22	33 3	31 38	30 7	28 24	26 29
18	38 15	37 7	35 58	34 47	33 33	32 13	30 46	29 10	27 21
19	38 26	37 22	36 17	35 9	33 59	32 43	31 21	29 50	28 7
20	38 35	37 34	36 32	35 28	34 21	33 9	31 52	30 25	28 47
21	38 43	37 45	36 46	35 45	34 41	33 33	32 19	30 57	29 24
22	38 50	37 55	36 58	36 0	34 59	33 55	32 44	31 26	29 57
23	38 56	38 3	37 9	36 14	35 15	34 14	33 6	31 51	30 26
24	39 1	38 10	37 19	36 25	35 30	34 30	33 25	32 14	30 52

ANGLES OF ELEVATION FOR 40 DEGREE BLANK.

Number of Teeth	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	20°13′	14°53′	9°24′	3°39′	......	......	......	......	......
6	30 48	26 21	21 48	17 3	11°58′	6°22′	......	......	......
7	36 37	32 52	29 2	25 3	20 49	16 12	11° 1′	5° 2′	......
8	40 7	36 53	33 36	30 10	26 33	22 38	18 16	13 20	7°23′
9	42 24	39 34	36 41	33 41	30 31	27 26	23 20	19 4	14 3
10	43 57	41 26	38 51	36 11	33 32	30 21	27 3	23 16	18 55
11	45 4	42 48	40 28	38 4	35 32	32 49	29 50	26 29	22 38
12	45 54	43 50	41 43	39 32	37 14	34 45	32 3	29 2	25 33
13	46 33	44 38	42 42	40 41	38 35	36 19	33 50	31 4	27 54
14	47 3	45 17	43 29	41 38	39 41	37 36	35 19	32 46	29 51
15	47 26	45 47	44 7	42 24	40 35	38 39	36 32	34 10	31 28
16	47 45	46 13	44 39	43 3	41 21	39 32	37 33	35 21	32 50
17	48 1	46 34	45 6	43 36	42 0	40 18	38 27	36 23	34 2
18	48 14	46 52	45 29	44 4	42 34	40 58	39 13	37 17	35 5
19	48 25	47 8	45 49	44 28	43 3	41 33	39 54	38 4	35 59
20	48 35	47 22	46 7	44 50	43 30	42 4	40 30	38 46	36 47
21	48 43	47 33	46 23	45 9	43 53	42 31	41 2	39 23	37 30
22	48 50	47 43	46 36	45 26	44 13	42 55	41 30	39 56	38 8
23	48 56	47 52	46 48	45 41	44 31	43 17	41 55	40 25	38 42
24	49 1	48 0	46 58	45 55	44 48	43 36	42 19	40 52	39 15

ANGLES OF ELEVATION FOR 55 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	12°13′	8°57′	5°37′	2°10′	......	......	......	......	......
6	19 17	16 25	13 30	10 28	7°15′	3°48′	......	......	......
7	23 35	21 4	18 31	15 51	13 4	10 3	6°44′	3° 1′	......
8	26 21	24 8	21 52	19 31	17 3	14 25	11 30	8 17	4°17
9	28 13	26 14	24 12	22 7	19 55	17 34	14 59	12 6	8 34
10	29 32	27 45	25 55	24 2	22 3	19 55	17 36	15 1	11 52
11	30 30	28 52	27 12	25 29	23 41	21 45	19 39	17 18	14 27
12	31 14	29 44	28 12	26 38	24 59	23 13	21 17	19 8	16 32
13	31 48	30 25	29 0	27 33	26 2	24 24	22 37	20 38	18 15
14	32 15	30 58	29 39	28 18	26 53	25 25	23 43	21 53	19 40
15	32 36	31 24	30 11	28 55	27 35	26 11	24 38	22 56	20 52
16	32 54	31 47	30 38	29 27	28 12	26 53	25 26	23 51	21 54
17	33 9	32 6	31 1	29 54	28 44	27 29	26 7	24 38	22 49
18	33 21	32 21	31 20	30 17	29 10	28 0	26 43	25 18	23 35
19	33 31	32 34	31 36	30 36	29 33	28 27	27 14	25 54	24 17
20	33 40	32 46	31 51	30 54	29 54	28 51	27 42	26 25	24 53
21	33 47	32 56	32 3	31 9	30 12	29 12	28 6	26 53	25 25
22	33 54	33 5	32 15	31 23	30 29	29 31	28 28	27 19	25 55
23	34 0	33 13	32 25	31 36	30 44	29 48	28 48	27 42	26 22
24	34 5	33 20	32 34	31 47	30 57	30 4	29 7	28 3	26 46

Since, however, the angles of a taper reamer are small, we can, by neglecting some of the factors which affect the result but slightly, arrive at something like workable expressions for the different settings.

Consider, first, the offset for a cylindrical piece, or say a straight hand reamer. Fig. 4 represents the end with one space cut. The cutter with which the space is cut has angles ϕ and ϕ_1 either side of the center so that the angle cut in the reamer is $(\phi + \phi_1)$.

Let $z =$ width of land; ρ half the angle subtended from the center by z; and x the offset.

We have, first, $\theta_1 = \theta - 2\rho$ and $\sin \rho = \dfrac{z}{2r}$. (6)

$$x = OA \sin \phi_1.$$

ANGLES OF ELEVATION FOR 60 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	10° 7′	7°25′	4°39′	1°47′	......	......	......	......	......
6	16 6	13 41	11 12	8 42	6° 2′	3° 9′	......	......	......
7	19 48	17 40	15 30	13 16	10 55	8 22	5°36	2°30′	......
8	22 13	20 19	18 24	16 24	14 19	12 4	9 37	6 53	3°44
9	23 52	22 10	20 26	18 39	16 46	14 46	12 34	10 7	7 19
10	25 2	23 30	21 56	20 19	18 37	16 48	14 49	12 36	10 5
11	25 54	24 30	23 4	21 35	20 2	18 23	16 34	14 34	12 16
12	26 34	25 16	23 57	22 36	21 10	19 39	17 59	16 9	14 13
13	27 5	25 53	24 40	23 25	22 6	20 41	19 9	17 27	15 31
14	27 29	26 22	25 14	24 4	22 51	21 32	20 6	18 32	16 44
15	27 49	26 46	25 43	24 37	23 29	22 15	20 55	19 27	17 47
16	28 5	27 6	26 7	25 5	24 1	22 52	21 37	20 14	18 40
17	28 18	27 23	26 27	25 29	24 28	23 23	22 13	20 55	19 26
18	28 29	27 37	26 44	25 49	24 52	23 50	22 44	21 30	20 6
19	28 38	27 49	26 58	26 7	25 12	24 14	23 11	22 1	20 42
20	28 46	27 59	27 11	26 22	25 30	24 35	23 35	22 29	21 14
21	28 53	28 8	27 23	26 36	25 46	24 54	23 57	22 54	21 42
22	29 0	28 17	27 34	26 49	26 2	25 12	24 17	23 17	22 8
23	29 5	28 24	27 43	27 0	26 15	25 27	24 35	23 37	22 32
24	29 9	28 30	27 50	27 9	26 26	25 40	24 50	23 55	22 52

ANGLES OF ELEVATION FOR 75 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	4°44′	3°28′	2°10′	......	......	......	......	......	......
6	7 38	6 29	5 19	4° 6′	2°50′	1°29′	......	......	......
7	9 29	8 27	7 24	6 17	5 10	3 57	2°38′	1°10′	......
8	10 44	9 48	8 51	7 50	6 51	5 45	4 34	3 14	1°45
9	11 36	10 46	9 54	9 0	8 5	7 5	6 0	4 49	3 27
10	12 14	11 28	10 40	9 52	9 1	8 7	7 8	6 3	4 49
11	12 42	12 0	11 16	10 32	9 45	8 56	8 2	7 1	5 54
12	13 4	12 25	11 45	11 4	10 21	9 35	8 45	7 49	6 47
13	13 21	12 45	12 8	11 29	10 50	10 7	9 21	8 29	7 31
14	13 34	13 0	12 26	11 50	11 13	10 33	9 50	9 2	8 7
15	13 45	13 13	12 41	12 7	11 33	10 55	10 15	9 30	8 39
16	13 54	13 24	12 54	12 22	11 50	11 14	10 37	9 54	9 7
17	14 2	13 33	13 5	12 35	12 5	11 31	10 56	10 16	9 31
18	14 8	13 41	13 14	12 46	12 17	11 45	11 12	10 34	9 51
19	14 13	13 48	13 22	12 55	12 28	11 58	11 26	10 50	10 10
20	14 18	13 54	13 29	13 4	12 38	12 9	11 39	11 5	10 27
21	14 22	13 59	13 36	13 12	12 46	12 19	11 50	11 17	10 41
22	14 25	14 3	13 41	13 18	12 53	12 28	12 0	11 29	10 54
23	14 28	14 7	13 46	13 24	13 0	12 36	12 9	11 40	11 6
24	14 31	14 11	13 50	13 29	13 7	12 44	12 18	11 50	11 18

ANGLES OF ELEVATION FOR 65 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	8°12′	6° 0′	3°46′	1°27′	......	......	......	......	......
6	13 7	11 10	9 8	7 4	4°53′	2°33′	......	......	......
7	16 13	14 28	12 41	10 50	8 54	6 49	4°33′	2° 1′	......
8	18 15	16 40	15 6	13 26	11 42	9 51	7 50	5 30	3° 1
9	19 39	18 14	16 48	15 19	13 45	12 5	10 16	8 14	5 57
10	20 40	19 23	18 4	16 44	15 19	13 48	12 9	10 19	8 15
11	21 25	20 14	19 3	17 49	16 31	15 9	13 38	11 58	10 4
12	21 59	20 54	19 48	18 40	17 28	16 12	14 49	13 17	11 32
13	22 26	21 26	20 35	19 22	18 15	17 5	15 48	14 23	12 46
14	22 48	21 52	20 55	19 56	18 54	17 48	16 37	15 17	13 48
15	23 5	22 13	21 19	20 24	19 26	18 24	17 18	16 4	14 40
16	23 18	22 29	21 39	20 47	19 53	18 55	17 53	16 43	15 24
17	23 30	22 43	21 56	21 8	20 17	19 22	18 23	17 17	16 3
18	23 40	22 55	22 11	21 25	20 37	19 46	18 50	17 47	16 37
19	23 48	23 5	22 24	21 40	20 55	20 6	19 13	18 14	17 7
20	23 55	23 14	22 35	21 54	21 10	20 24	19 33	18 38	17 34
21	24 1	23 22	22 45	22 6	21 24	20 39	19 51	18 58	17 58
22	24 6	23 29	22 53	22 16	21 36	20 53	20 8	19 17	18 20
23	24 11	23 36	23 1	22 26	21 47	21 7	20 23	19 34	18 39
24	24 15	23 43	23 8	22 34	21 57	21 18	20 36	19 50	18 57

ANGLES OF ELEVATION FOR 80 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	3° 7′	2°17′	1°26′	0°43′	......	......	......	......	......
6	5 2	4 16	3 30	2 42	1°52′	0°58′	......	......	......
7	6 16	5 35	4 53	4 10	3 25	2 36	1°45′	0°46′	......
8	7 6	6 29	5 51	5 12	4 31	3 48	3 2	2 8	1° 8′
9	7 42	7 8	6 34	5 58	5 21	4 42	3 59	3 11	2 17
10	8 7	7 36	7 5	6 33	5 59	5 22	4 44	4 0	3 11
11	8 26	7 58	7 29	7 0	6 28	5 55	5 19	4 39	3 54
12	8 41	8 15	7 48	7 21	6 52	6 22	5 48	5 11	4 29
13	8 53	8 29	8 4	7 38	7 12	6 43	6 12	5 38	4 59
14	9 2	8 40	8 16	7 52	7 28	7 1	6 32	6 0	5 24
15	9 9	8 48	8 26	8 4	7 40	7 16	6 48	6 19	5 45
16	9 15	8 55	8 35	8 14	7 51	7 28	7 3	6 33	6 3
17	9 20	9 1	8 42	8 22	8 1	7 39	7 15	6 49	6 19
18	9 24	9 6	8 48	8 29	8 10	7 49	7 26	7 1	6 33
19	9 28	9 11	8 53	8 36	8 17	7 58	7 36	7 12	6 45
20	9 31	9 15	8 58	8 42	8 24	8 5	7 44	7 21	6 56
21	9 34	9 19	9 3	8 47	8 30	8 12	7 52	7 30	7 6
22	9 36	9 22	9 6	8 51	8 35	8 18	7 59	7 38	7 15
23	9 38	9 24	9 9	8 55	8 39	8 23	8 5	7 45	7 23
24	9 40	9 26	9 13	8 59	8 43	8 28	8 11	7 51	7 30

ANGLES OF ELEVATION FOR 70 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	6°25′	4°42′	2°57′	......	......	......	......	......	......
6	10 18	8 44	7 9	5°32′	3°48	......	......	......	......
7	12 47	11 23	9 59	8 31	6 58	5°21′	3°33′	......	......
8	14 26	13 11	11 55	10 36	9 14	7 45	6 9	4°23′	2°21
9	15 35	14 27	13 18	12 7	10 53	9 33	8 6	6 30	4 41
10	16 25	15 23	14 21	13 15	12 8	10 55	9 37	8 9	6 30
11	17 2	16 5	15 8	14 8	13 7	12 0	10 48	9 28	7 57
12	17 30	16 38	15 45	14 50	13 53	12 51	11 45	10 31	9 8
13	17 52	17 4	16 15	15 24	14 30	13 33	12 32	11 23	10 6
14	18 9	17 24	16 38	15 51	15 1	14 8	13 11	12 7	10 55
15	18 23	17 41	16 58	16 14	15 28	14 38	13 44	12 44	11 37
16	18 35	17 55	17 15	16 33	15 50	15 3	14 13	13 17	12 13
17	18 45	18 7	17 30	16 50	16 9	15 25	14 38	13 46	12 45
18	18 53	18 17	17 42	17 5	16 26	15 44	14 59	14 10	13 13
19	19 0	18 26	17 52	17 17	16 40	16 1	15 18	14 32	13 38
20	19 6	18 35	18 1	17 28	16 53	16 16	15 35	14 51	13 59
21	19 11	18 41	18 9	17 38	17 5	16 29	15 50	15 8	14 18
22	19 15	18 46	18 16	17 46	17 15	16 40	16 3	15 22	14 35
23	19 19	18 51	18 23	17 54	17 25	16 50	16 15	15 36	14 51
24	19 22	18 55	18 29	18 0	17 33	16 59	16 25	15 48	15 5

ANGLES OF ELEVATION FOR 85 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	1°33′	1° 8′	......	......	......	......	......	......	......
6	2 30	2 7	1°44′	1°20′	0°55′	......	......	......	......
7	3 7	2 46	2 26	2 4	1 42	1°18′	0°50′	......	......
8	3 32	3 13	2 55	2 35	2 15	1 53	1 29	1° 3′	0°34′
9	3 50	3 33	3 16	2 58	2 40	2 20	1 59	1 35	1 8
10	4 3	3 48	3 32	3 16	2 59	2 41	2 21	1 59	1 35
11	4 13	3 59	3 44	3 30	3 14	2 57	2 39	2 19	1 57
12	4 20	4 7	3 53	3 40	3 25	3 10	2 53	2 35	2 15
13	4 26	4 14	4 1	3 48	3 35	3 21	3 6	2 48	2 30
14	4 30	4 19	4 7	3 55	3 43	3 29	3 15	2 59	2 42
15	4 34	4 23	4 12	4 1	3 50	3 37	3 24	3 9	2 52
16	4 37	4 27	4 17	4 6	3 56	3 44	3 30	3 17	3 1
17	4 40	4 30	4 21	4 11	4 1	3 50	3 37	3 24	3 9
18	4 42	4 33	4 24	4 15	4 5	3 55	3 43	3 30	3 16
19	4 44	4 35	4 27	4 18	4 9	3 59	3 48	3 36	3 22
20	4 46	4 37	4 29	4 21	4 12	4 3	3 52	3 41	3 28
21	4 47	4 39	4 31	4 23	4 15	4 6	3 56	3 45	3 33
22	4 48	4 41	4 33	4 25	4 18	4 9	3 59	3 49	3 37
23	4 49	4 42	4 35	4 27	4 20	4 12	4 2	3 53	3 41
24	4 50	4 43	4 36	4 29	4 22	4 14	4 5	3 56	3 45

From well-known trigonometrical relations,

$$\frac{r}{\sin\,[180 - (\phi + \phi_1)]} = \frac{OA}{\sin\,[180 - (180 - (\phi + \phi_1) - \theta_1)]}$$

from which $OA = \dfrac{r \sin\,[(\phi + \phi_1) - \theta_1]}{\sin\,(\phi + \phi_1)}$.

Therefore $$x = \frac{r \sin \phi_1 \sin\,(\phi + \phi_1 - \theta_1)}{\sin\,(\phi + \phi_1)}. \qquad (7)$$

Example: What would be the offset for a 1 1/8-inch reamer, 8 teeth, lands 1/16 inch wide, to be cut with a double angle cutter having angles of 15 and 65 degrees?

$$\theta = \frac{360}{8} = 45 \text{ deg.}; \sin \rho = \frac{0.0625}{1.125} = 0.0555, \text{ or } \rho = 3 \text{ deg. } 11 \text{ min.}$$

$$\theta_1 = 45 \text{ deg.} - 6 \text{ deg. } 22 \text{ min.} = 38 \text{ deg. } 38 \text{ min.}$$

$$\phi + \phi_1 = 80 \text{ degrees.}$$

$$\phi + \phi_1 - \theta_1 = 80 \text{ deg.} - 38 \text{ deg. } 38 \text{ min.} = 41 \text{ deg. } 22 \text{ min.}$$

$$\text{Then } x = \frac{0.562 \sin 15 \text{ deg.} \times \sin 41 \text{ deg. } 22 \text{ min.}}{\sin 80 \text{ deg.}} = \frac{0.562 \times 0.2588 \times 0.6608}{0.9848} = 0.098.$$

Reamers are usually cut with 90-degree cutters, the Brown & Sharpe standard tap and reamer cutter having angles of 30 and 60 degrees. If we were using one of these instead of the one considered, the work of calculation would be much simplified, for with $\phi + \phi = 90$, equation (7) becomes

$$x = r \sin \phi_1 \cos \theta_1 \qquad (8)$$

Equation (7) is strictly true for a straight tap or reamer, but only approximately so for a taper tap or reamer. The reason for this is that in deducing the expression for set-over, our angles lie in a plane perpendicular to the axis of cylinder. As soon as this axis is changed by elevating the tail center as in the case with a taper, we shift this plane by an angle equal to the angle of elevation. Projecting the angles back then onto the original plane modifies them to

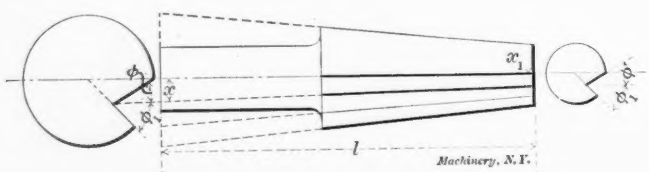


Fig. 5. Case of a Taper Reamer milled by a Double-angle Cutter.

some extent, and hence the error. For a taper reamer with a taper not exceeding 1 inch per foot, the error can be neglected, being within the limits of accuracy of the setting of the machine. We may, therefore, use equations (7) and (8) for taper reamers with tapers not exceeding 1 inch per foot, the same as equation (5) previously referred to.

It should be borne in mind that there are two kinds of set over, one which may be called the *table set over* in which the table, centers and all are moved over a certain distance, and another, the *center set over* in which one or the other of the centers is set over. To make this a little more apparent suppose we have a reamer ½ inch diameter at the small end and 1 inch at the large end. By equation (7) we find the set over for the large end to be 0.17 inch, while for the small end, it is 0.12 inch. If we move the table off center 0.17 inch for the large end, it will be over too far for the small end, while if it is adjusted right for the small end, the large end will not be over far enough. Swinging the table through a horizontal angle will not compensate for this difference, for the line of travel of the table will still be in the line of centers. It is therefore necessary to shift one or the other of the centers by an amount equal to the difference between the table set-over for the large and small ends of the reamer. See Fig. 5.

It follows from what has been said that unless provision has been made to adjust the tail center of a milling machine sidewise, it is impossible to cut a taper reamer with a double angle cutter without having the cutting edges of the teeth twisted with relation to the center line. If the work be held on the index head independently of the tail center, the head must be turned through a horizontal angle to escape the same consequences.

There is still one more thing to be considered. The vertical adjustment or elevation of the tail center as given by equation (5) is for a single angle cutter. For a double angle cutter this should be multiplied by the cosine of the angle of the double angle cutter which cuts the radial face of the tooth, or if we call this new elevation E_1,

$$\text{then } E_1 = E \cos \phi_1, \qquad (9)$$

Collecting these equations together, we have:

Single angle cutter:

Angle of elevation, α, for angular cutters $= \gamma - \delta$, (1)

$\tan \gamma = \cos \theta \cot \beta$, (2)

$\sin \delta = \tan \theta \cot \phi \sin \gamma$, (3)

For end mill $\cos \alpha = \tan \theta \cot \phi$, (4)

In terms of taper per foot, elevation of tail center

$$E = \frac{Tl}{24} (\cos \theta - \sin \theta \cot \phi), \qquad (5)$$

Double cutter angle:

$$\theta_1 = \theta - 2\rho; \ \sin \rho = \frac{z}{2r}, \qquad (6)$$

$$\text{Table set over } x = \frac{r \sin \phi_1 \sin (\phi + \phi_1 - \theta_1)}{\sin (\phi + \phi_1)} \qquad (7)$$

Table set over for 90-deg. cutter $x = r \sin \phi_1 \cos \theta_1$ (8)

Elevation of tail center $E_1 = E \cos \phi_1$. (9)

The use of a double angle cutter has several advantages over the single. The pressure of cut comes more nearly over the center of the work, and there is no drag of the cutter teeth along the radial faces of teeth being cut, and hence a smoother cut is possible. A small angle to the side of a cutter makes it clear the work much the same as swinging the tool box of a planer causes the tool to clear on the return stroke when planing a vertical surface. We are enabled to use formed cutters which can be ground without changing their form. However, in view of the difficulties in making the adjustments, it is questionable whether the single angle cutter would not be the better.

* * *

The writer of a sensational story in the *Saturday Evening Post* which details the alleged experience of a convict in a States' prison, causes his chief figure in the drama to do certain stunts that rather take away a mechanic's breath. For example: "From the machine shop in the foundry (sic) he stole a big heavy file . . . At length he stole from the machine shop another file, a smaller one of diamond (sic) steel and with it he began to sharpen the big one of softer steel into a knife." This seems like a rather big and discouraging job, even for a convict with unlimited time at his command. Again: "He took ten needles and fitted them into the wooden stem of a brier pipe . . . close together like the teeth of a comb. They were hard; they made a diminutive saw; and they bit steel. With these needles he began to saw off his bars. He sawed for a year and had three bars nearly through," etc. A convict who can make a saw out of ten sewing needles that will cut through three steel bars ¾ inch in diameter ought to have a gold medal. He is a genius whose ability exceeds that of an Edison. Some file makers should get his name and address. The lucky one will make a revolution in file manufacture!

* * *

The construction and location of a machine shop tool room often is a somewhat difficult matter to decide upon. The location should be as central as the construction of the shop will permit, and its construction should be elastic to permit of growth with the growth of the shop, but any system of wooden drawers and shelves is objectionable, both because of lack of elasticity and the fire risk. Mr. Lucas, of the Lucas Machine Tool Co., Cleveland, O., proposes to make a new tool room in his enlarged shop of steel unit-drawn sections about four feet high, 12 to 14 inches wide, and 30 inches long, placed side by side, so as to enclose an area large enough for the tool room machines and attendants. All these steel units contain drawers for tools and supplies, but not all the units will have the drawers opening into the tool room. Part of them will be reversed so that the drawers will be accessible to the operators of machines in the immediate vicinity. This scheme has the merit of simplicity and extensibility. The only addition required to the steel units to form a tool room enclosure is a gate and a low wire net fence along the top. Such a construction does not interpose an obstruction to a general survey of the shop. It permits the tool room to be easily moved, extended or changed whenever the shop conditions require it, and is a construction durable and fireproof.

DESIGN AND CONSTRUCTION OF METAL-WORKING SHOPS—3.

W. P. SARGENT.*

In considering the building of a new and enlarged plant with the aim of attaining the lowest possible cost of product and the highest possible productive efficiency, the first question is naturally—"Where shall we build?" In answering this question, with the country at large as a field, one would probably choose a site in the vicinity of Pittsburg or Birmingham if the cost of material greatly exceeded the cost of labor in a given product. Chicago, St. Louis, or Cincinnati, would be the choice for superior shipping facilities, and the vicinity of Niagara Falls would be favored for low cost of power. The outskirts of large manufacturing cities would be the most favorable from the standpoint of adequate labor supply. Taking all things into consideration, the Middle West, in the light of its wonderful industrial advance during the past decade, furnishes a happy medium between the advantages of the other sections of the country. It will provide an adequate labor supply of all grades, cheap fuel (coal at \$1.00 to \$2.00 per ton), and an abundance of excellent factory sites at a reasonable cost for land.

Who has not, within a few minutes after leaving any of the large manufacturing cities of this section, looked from the car window, first, on flat tracts of land parcelled into lots with cement sidewalks and occasional houses, and with electric interurban cars probably in view, and a little later upon level farms, with possibly a water course in the foreground and a streamer of smoke in the distance indicating the existence of another railroad. There is a good site for a large works, as such land can be purchased for \$250 to \$500 per acre, and often in single tracts of 150 to 200 acres from one owner. Low spots somewhat removed from the natural building location should not be considered as detrimental, as they are needed for dumps for foundry dirt and ashes, which will amount to 5,000 cubic yards per year from a plant such as will be described.

A farm may not seem to be the best site for machine shops, perhaps because the intense activity of a large plant is in such contrast to the quietude of a farm that the superior advantages may not appeal strongly; and doubts may be entertained of the securing and retaining of men in competition with the glamor of residing in the crowded city districts. That adjacent land, however, will be parcelled out for building lots, and that there will be a colony of homes before a large new works is in operation, is almost a certainty; and that the more reliable class of workmen will be attracted, is equally certain.

If the site chosen is within the city limits, there will be but a single fare on street cars, and the new plant will secure the benefits of municipal fire, water, and sanitary service to supplement its own service. But the non-success of securing a desirable site within the city limits need not deter the building of the plant just outside the limits. Any railroad will be glad to run a special morning and evening service to accommodate the workmen living within the city. Fire insurance rates will, however, approximate 25 cents per \$100 more, if the plant is outside the municipal fire service limits. The well known tendency of cities to grow in the direction of industries in the outskirts, will in time bring fire service, at least soon enough to provide reserve facilities when extension of the works is necessary. But, of course, works of large size should be sufficiently protected by their own appliances not to be dependent.

Fig. 19 shows one of a number of fine sites about three miles from the center of a manufacturing city of 35,000 inhabitants. The line of trees in the distance is on the bank of a stream that would furnish water for all purposes except for drinking. Wells can be driven almost anywhere in the vicinity, and an abundance of pure cold water obtained. Beyond and paralleling the stream is a street with an interurban electric line; and about half a mile south a steam road crosses the street and parallels the stream, thus giving to the site a road on either side. The space is sufficient to allow of a rectangular site being laid out about 1,500 feet east and west and 2,000 or 3,000 feet north and south.

Preliminary Estimate.

We will now get to work on a general estimate of the amount of land required, and of the approximate cost of the project, basing the space figures on those given in column 1 of Table VIII. We will tentatively plan the layout of a new and complete plant to employ 1,500 men on medium and heavy machine tools. How much land will be required and how much space under roof will be required to work 1,500 men in all departments, or, in other words, to increase the production to \$3,000,000 per year at \$2,000 per man? The number of square feet per man under roof is given as 368, which applies during crowded conditions and includes a number of shacks and a large percentage of pattern storage. It should be noted that the percentage of total space under roof to the total space for machining is 540 as compared with 341, the mean of the plants Nos. 5, 6, 7, 8 and 9, but as all the details will not be considered in this broad estimate, we will use the figure given, being on the safe side, and will consider that the corporation officials would make their own allowances on the sum total of the money to be spent, anyway.

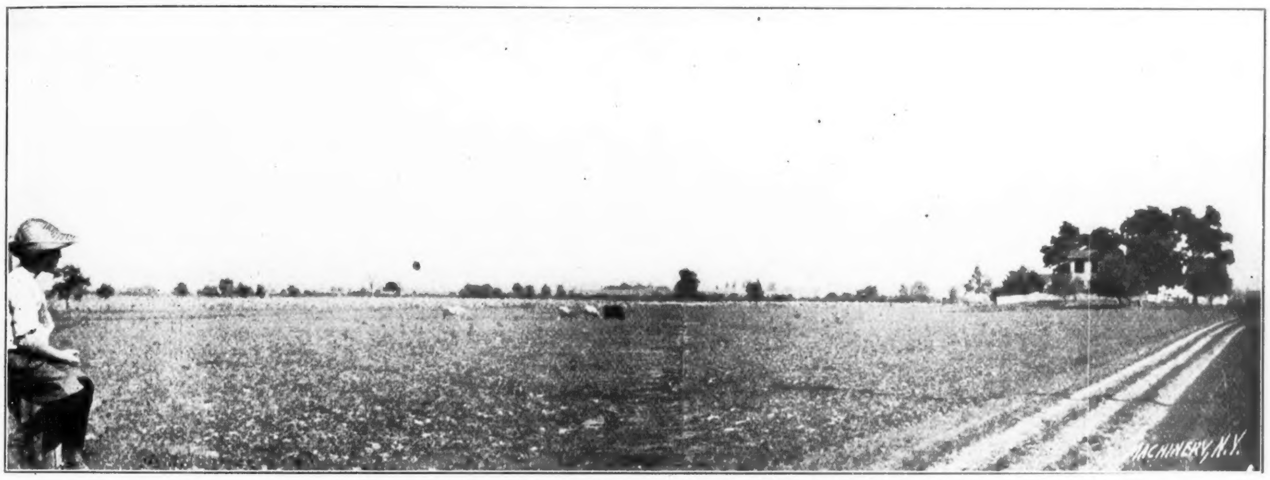


Fig. 19. A Site for a Large Works, possessing Many Advantages.

Space Occupied by Buildings and Total Ground Space.

For the total floor space take 1,500 men at 368 square feet each, as requiring in round numbers 550,000 square feet. We will assume that 25 per cent of this space will be galleries, reducing the total 137,500 square feet, and making the total ground floor space under roof 412,500 square feet. We will adopt a rectangular layout similar to that of the West Allis Plant and will therefore multiply 412,500 by 2 and get 825,000 square feet as the total of the ground space within the building rectangle. Increasing this by 60 per cent, to provide for extensions to make the total number of men employed 2,500, adds 495,000 square feet, making 1,320,000 square feet, sufficient to cover all the building ground space ever required. The area for trackage may be taken as 50 per cent or 660,000, making the grand total that should be purchased 1,980,000 square feet or 45.5 acres, or 50 acres in round numbers.

* Address: 315 South First St., Rockford, Ill.

Approximate Cost Estimate of New Plant.

Taking a maximum of $500 per acre makes the investment in land $25,000 .... $ 25,000

We will aim to keep the cost of buildings of all classes within an average of $1.70 per square foot, and for 550,000 feet of floor space the total cost of buildings may be placed at $935,000..... 935,000

For power equipment we will assume one I. H. P. per man; 1,500 H P. of boilers, including reserve battery stokers, piping, auxiliaries, engines, generators, switch-boards, and coal-handling and storage apparatus at $90 per H. P., totals...... 135,000

It is rather difficult to arrive at the cost of cranes using a unit figure, but if we assume that 400,000 square feet of space inside and outside will be served by cranes at 50 cents per square foot, the total cost will be about $200,000.............. 200,000

Heating: Taking 412,500 square feet occupied by buildings and multiplying by an average height of 50 feet gives us 21,000,000 cubic feet as the approximate cubical contents; with a ratio of 150, this requires the equivalent of 140,000 feet of direct radiation, which at 60 cents per foot, and with some extra allowance, makes the cost for this item in the neighborhood of $90,000... 90,000

The nominal horse-power of motors required for direct and group driving approximates 1 H. P. per man and 1,500H. P. of motors at $15 per H. P.. 22,500

Trackage in the yards will approximate 6 miles at $9,000 per mile 54,000

Switch engine, locomotive crane, and rolling stock.. 12,000

The sprinkler equipment and inside piping will cost 7 cents per square foot for 550,000 square feet—$38,500—and 10 cents per square foot for yard piping, tanks, etc.—$55,000—totals............ 93,500

The machine tool equipment will cost about $600 per man or for 1,500 men $900,000 or about $8.00 per square foot of space used for machining. But if a new shop replaces an old one, the machine tool equipment would certainly be moved, and it is probable that the new tools needed at the beginning would be covered by the sum of $200,000, leaving the remaining tools to be purchased when needed 200,000

The above items indicate a gross expenditure of $1,767,000

Taking a range both ways we will say that the plant can be built for $1,600,000 to $2,000,000, of which there could be charged off an amount equal to the market value of the old plant and of equipment not removed to the new plant.

It is a difficult thing to find a customer for old shoes which the owner has outgrown and worn out, especially of such a size, and it is hardly probable that a corporation will release to the ravages of time and man, a property which for $500,000 could be enlarged and improved to employ 1,500 men even though the limit of expansion would be reached. Only a corporation so happily situated as to have built and grown in the heart of a metropolis, with the value of its real estate enhanced to the extent that the proceeds of the sale of its ground would partly build the new plant, would consider a proposition of this size. Possibly also a concern having absolutely reached its limits of expansion would decide upon eventually having a plant that would be right, and would plan as a whole, and build in part, as their needs necessitated and their resources would permit.

A new plant, however, is what all overgrown concerns would like to see, and the writer will proceed on the assumption that the means would be forthcoming, especially as the designing of a new plant of this size will cover most of the problems that arise in planning the extension of old plants.

TABLE VIII. COMPARATIVE FLOOR SPACE DATA IN SOME REPRESENTATIVE SHOPS.

	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.		No. 7.		No. 8.		No. 9.	
	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.
Machining, First Floor	55,900	100.0	30,500	100 0	276,500	100.0	63,000	100.0	122,000	100.0	135,700	100.0	158,000	100.0	137,000	100.0	55,000	100.0
" Gallery	19,000										54,050		62,600					
Assembling	70,000	93 0	16,500	54 0	43,500	16.0	26,700	42.0	68,000	55.0	40,750	21.5	109,000	50.0	55,400	40.0	30,100	54.0
Work in Progress	1,600	2 0					6,000	9.5	10,000	8.0								
Tool Making	2,600	3.5					8,000	12.5	10,000	8.0			6,400	3.0				
Tool Storage	3,700	5.0					8,000	12.5	15,000	12.0								
Machine Shop Stores	5,100	7.0	8,150	26.5			13,000	20.0	36,500	30.0			12,800	6.0			13,300	24.0
Wash Room	500	0.5					8,000	12.5	13,000	10.5								
Shop Offices	100						1,000	1.5	1,000	1.0								
Machine Shop, Total	158,500	211.0	55,150	180.5	320,000	116.0	133,700	210.5	275,500	224.5	230,500	121.5	348,000	159.0	192,400	140.0	98,400	180.0
Finished Storage	13,000	17.5	8,150	26.5			15,000	24.0	29,000	24.0			17,000	7 5	31,000	22.5	10,000	18.0
Shipping	9,700	13.0					7,500	12.0	8,000	6.5	21,500	11.5	22,000	10.0				
Foundry, Iron	83,650	112.0	16,000										140,300	63 0	106,500	78.0		
" Brass	5,820	8.0											22,000	10.0	2,400	2.0		
" Steel																		
Foundry Total	89,470	120.0	16,000	52.0	143,000	52.0	20,000	32.0	31,000	25.0	132,000	70.0	162,300	73.0	108,900	80.0	43,350	79.0
Casting Storage	15,000	20.0					42,000	67.0					67,500	30.5				
Storage, Flask	32,000	43.0					30,000	48.0	20,000	16.5					25,000	18.0	30,000	54.0
" Pig Iron	30,000	40.0					2,000	3.0	600	0.5			80,000	36.0	14,000	10.0	6,600	12.0
" Coke	2,300	3.0					300	0.5	400	0.5								
" Sand	5,000	7.0	500	1.5			700	1.0	5,000	4.0			9,000	4.0	10,200	9.5		
" Supplies	7,600	10.0							200									
Smith Shop	12,500	16.5	1,730	5.5	12,000	4.5	9,000	14.5	9,000	7.5	50,150	26.5	9,100	4.0	19,200	14.0	3,100	5.5
Iron Storage	5,000	7.0					10,000	16.0	10,000	8.0								
Coal Storage	1,600	2.0																
Pattern Shop	11,000	14.5	1,730	5.5	29,000	10.5	4,500	7.0	8,900	7.5	31,000	16.5	22,600	10.0	14,400	10.5	7,400	13.5
" Storage	60,000	80.0	8,900	29.0	83,000	30.0	16,000	25.0	26,000	21.0	144,900	76.0	67,500	30.5	50,400	37.0	29,200	54.0
Carpenter Shop	3,100	4.0	1,670	5.5											5,600	4.0		
Lumber Storage	7,400	10.0					4,000		4,000	3.5								
Engine Room	5,000	7.0	700	2.5			1,400	2.0			8,850	4.5	8,540	4.0	9,260	6.5	2,100	4.0
Boiler Room	4,100	5.5	1,080	3.5			2,100	3.5	1,750	1.5	8,850	4.5	8,700	4.0	8,500	6.0	1,920	3.5
Pump Room	800	1.0							900	1.0								
Electricians	300	0 5					800	1.0	1,400	1.0			18,000	8.0				
Coal Shed	7,000	9 5							2,400	2.0			2,500	1 0	5,000	3.5		
Offices	3,500	4.5	4,000	13.0	29,000	10.5	4,600	7.0	15,000	12.0			22,500	10.0	24,000	17.5	1,500	2.5
Drawing Room	5,200	7.0			11,000	4.0	4,000	6 5	6,000	5.0			7,500	3.5			3,000	5.5
Space Occupied	479,070	640 0					307,600	488.0	455,050	373.0			873,540	396 0	517,860	378.0	236,570	430.0
" Under Roof	404,670	540.0	99,610	326.0	627,000	227.0	228,600	363.0	420,850	345.0	627,750	330.0	717,040	325.0	467,860	341.0	199,970	363.0
" Occupied per Man	436						342											
" Under Roof, per man	368				330		254											
Number of Buildings	50		15				20		11		6		10		17		14	
Number of Men	1,100				1,900		900											
Product.	Medium and Heavy Machine Tools.		Light and Medium Machine Tools.		Medium and Heavy Engines and Mining Machines.		Light and Medium Machine Tools.		No. 4, after Rebuilding Space Allotted.		Heavy Engines. Expansion of No.3.		Light, Medium, Heavy Pumps. Condensers.		Compressors, Rock Drills, Light, Medium, Heavy.		Corliss Engines, Turbines, Pumps.	

Plants Nos. 1, 2, 3, and 4 are unimproved. Plant No. 5 is rebuilt. Others are entirely new.

The General Layout.

Referring to Table VIII, the reader will notice that the percentages are based on the space used for machining (sepa-

rated from the tool-making and supply departments, which are included in the figures given for the machine shop total), but should be considered as approximate for the plants that are not given in detail. Table IX takes into account the number of men, and the modifications necessary to form unit figures that can be used as the basis for laying out the new plant.

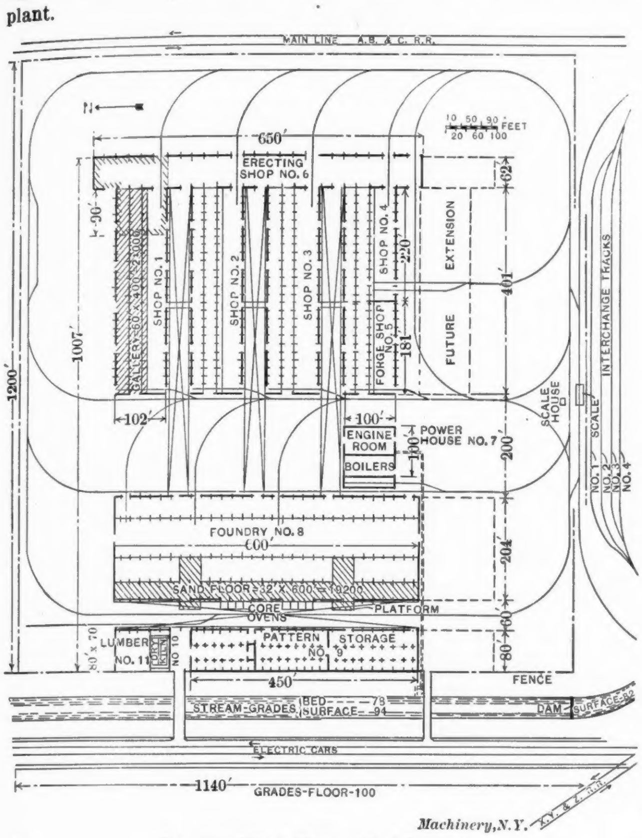


Fig. 20. Block Plan of Model Plant.

As the relative number of men in the different departments is constantly changing, and the departments are not all at their highest efficiency at the same period, it is necessary to analyze each department separately, and the composite figures obtained will probably differ from the data obtained for any definite date. For instance, the number of men given in Table IX is not the number employed at the time that the foundry complement was compiled, but figures are taken that balance better.

In the works from which these figures were obtained the space is badly broken up. The main erecting bay—50 feet wide—is not wide enough to erect a double line of the heavy machines at one time and utilize the space to the best advantage. Work that should be placed adjacent to the tools ready for machining is sandwiched in between machines undergoing erection, thus making the erecting space, to a great extent, merely storage space for work in progress. In a building intended for erecting only, the amount of this waste space should be transferred to the machining space, and it should be noted that the figures for square foot per man are modified, and 300 square feet per man is taken as a unit for both erecting and machining space. The foundry space is crowded, so the unit per man is made 250 square feet. The total number of men is reduced to a unit of 357 or approximately 1/3, allowance being made in the foundry for expected superior arrangement, and in the pattern shop for the employment of a greater proportion of men to expedite work from the drawing-room to the foundry. It should be noted that the modified space ratios correspond better with those of the new plants in Table VIII.

The unit figures are multiplied by 4 to provide for an increase in force to 1,500 men, or approximately 33 per cent more. If later extensions are needed, the addition of another unit will provide an increase of 25 per cent; and if we lay out our buildings right, the extensions can be made without interfering with the production in the least. We can now block out roughly the size of the main buildings, basing our conclusions on the data from Table X.

Erecting Shop.

The heavy erecting space in bays 2 and 6 in Table X is 27,500 square feet, and the medium erecting in bays 1, 3, 4, 5, and 9, occupies 30,500 square feet. The widths of the bays vary from 35 to 50 feet, and as the widest are not wide enough to erect a double line of machines, and the narrow ones do not economize room, we will consider that a width of 60 feet will not be excessive or detrimental to the effective use of the cranes. It should be remembered that the bridge traverse of cranes is more rapid than the trolley traverse; traverse of cranes is more rapid than the trolley traverse, can be increased proportionately; or, what amounts to the same thing, the trolley will have a chance to accelerate to the highest speed and even get a short run at the high speed, on a crane speeded as they ordinarily are.

From the erecting space (67,200 square feet) in Table IX, the amount required for fitting (17,200 square feet) is deducted, leaving 50,000 square feet as the space that should be considered for the main erecting space. Dividing by 62 feet (the crane span plus 2 feet) we get 806 feet as the approximate length of the erecting shop. This is merely a tentative figure, as we may want to modify the dimensions on account of considerations of space distribution.

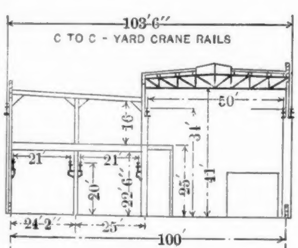


Fig. 21

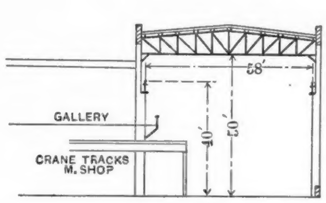


Fig. 22

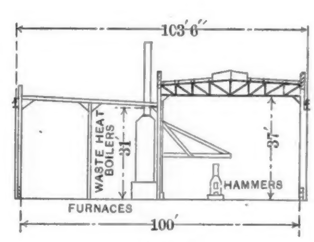


Fig. 23

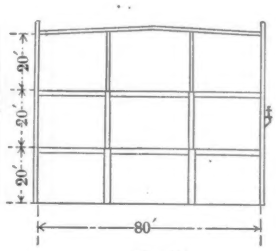


Fig. 24

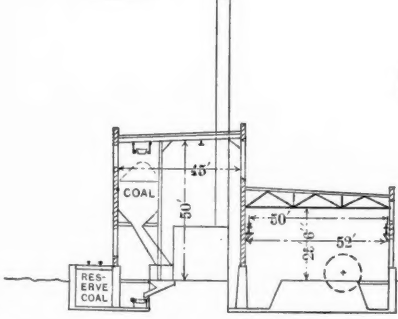


Fig. 25

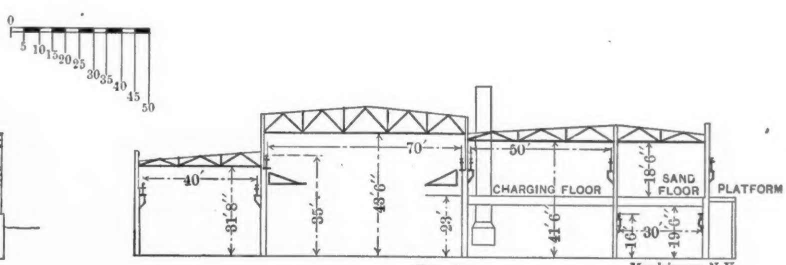


Fig. 26

Machinery, N.Y.

Fig. 21. Cross-section of Shops Nos. 1, 2, 3 and 4, in Fig. 20. Fig. 22. Erecting Shop. Fig. 23. Forge Shop. Fig. 24. Pattern Storage. Fig. 25. Power House. Fig. 26. Foundry.

For the machining, we have plenty of latitude in the arrangement of space, as the percentage of the total machine space that requires cranes of 15-ton capacity is about 11

per cent. This percentage of the 172,800 square feet required for machining is 19,000 square feet, and a bay 52 feet wide and 400 feet long will be ample, leaving 152,000 square feet to be taken care of by galleries and smaller crane bays. Before settling on a cross-section for the machine shops, the percentages of the space under cranes, and that used for the heavy and medium work should be determined from Table X, and the amount of space for a complete unit (from Table IX) apportioned accordingly.

We have the following figures from the preceding discussion. 1. A width of about 60 feet for the erecting shop. 2. A main bay in one machine shop about 50 feet wide and 400 feet long. Summing up the machining space in Table X that is not served by cranes, we get 48,000 square feet and this equals 54 per cent of the total of 88,000 square feet in the old shops. Taking 54 per cent of the desired 172,800 square feet, we get 93,000 square feet of space that can be on galleries or under galleries. The planers occupy about 29 per cent, and this calls for 50,000 square feet in the new shops.

To secure low cost and quick delivery of construction material, it is self-evident that the buildings should be as nearly alike as possible in dimensions and details, following the methods of all successful manufacturing, in providing for duplicate parts in large lots. As the space will not permit of the discussion of all the steps leading up to a tentative plan, the block plan Fig. 20 is presented together with a brief explanation of the reasons for the arrangement and proportions, wherever the conclusion has not been reached in the preceding paragraphs.

It should be noticed that 180 feet in length of Unit No. 4 has been modified for use as smith shop. As we have been generous in the space allowed per man in this department, this shop (by night work, if

TABLE IX. GENERAL DATA AS COMPILED FROM PLANT NO. 1 AND AS MODIFIED FOR USE IN DETERMINING SPACE-FIGURES FOR A NEW PLANT WITH 1500 MEN.

Actual Data.					Modified Data.					
					One Unit.			Four Units.		
Department.	Square Feet.	Ratio, per cent.	Men.	Sq. Ft. per Man.	Men.	Sq. Ft. per Man.	Sq. Ft. per Unit.	Ratio. per ct.	Men, Total.	Total Sq. Ft.
Machining	88,000	100.0	382	230	144	300	43,200	100.0	576	172,800
Erecting	58,000	80.0	188	370	56	300	16,800	38.8	224	67,200
Assembling	12,000									
Total	158,000	180.0	570	277	200	300	60,000	138.8	800	240,000
Foundry, Iron	83,650	95.0	350	240	122	250				
" Brass	5,820	6.5	25	233	8	250				
Foundry Total	89,470	101.5	375	238	130	250	32,500	75.0	520	130,000
Pattern Shop	11,000	12.5	30	365	15	365	5,480	12.7	60	21,920
Smith Shop	12,500	13.0	35	380	12	380	4,560	10.5	48	18,240
Total	270,970	307.0	1,010	268	357	287	102,540	237.0	1,428	410,160

TABLE X. DATA FROM PLANT NO. 1.

A—Crane Track Span. B—Crane Track Height. C—Floor to Roof-truss. D—Width between Columns.

Bay No.	A	B	C	D	Cranes.	Machining Space.	Erecting Space.	Assembling Space.	Remarks.
1	51′	21′ 5″	27′ 9″	50′	2–15 ton		10,000		Medium Work.
2	50′	23′ 4″	31′ 6″	49′	1–25 ton 2–20 ton		20,000		Heavy Work.
3	41′	24′ 4″	30′ 6″	40′	1–15 ton*		6,000		Medium Work.
4	40′ 8″	22′	27′	42′	2–10 ton	6,000	8,000		Boring Mills. Medium Erecting
5	38′ 2″	24′	31′ 2″	37′	1–15 ton*	2,000	4.000		Medium Erecting. Planers.
6	36′ 1″	24′	31′ 2″	35′	1–20 ton 1–15 ton	6,500	 7,500		Large Planers. Large Erecting.
7	20′	15′	17′ 9″	21′	3– 3 ton	2,000		6,000	Next to No. 2.
8			17′ 9″	21′		4,000		4,000	Next to No. 7.
9			18′	45′	2–hand	4,500	2,500	2,000	Medium Work.
10			12′	45′		19,000			Gallery.
11			17′	37′		13,000			Small Planers.
12			16′	17′		3,400			Light Work.
13			14′	41′		8,000			Light Work.
14			15′	20′		3,300			Planers.
15			15′	20′		3,300			Light Work.
16			14′	40′		13,000			Light Work.
Totals of Machine Shop Departments						88,000	58,000	12,000	
1	58′	30′ 4″	38′ 4″	56′ 9″	3–30 ton				Foundry.
2	30′	17′ 3″	18′ 9″	30′ 7″	1– 5 ton				Side Bay.
3	30′	17′ 3″	18′ 9″	29′ 7″	1– 5 ton				Side Bay.
			12′	41′					Pattern Shop.
			20′	63′					Smith Shop.

* Cranes in Bays Nos. 3 and 5 are obsolete.

TABLE XI. SPACE ALLOTMENT. MODEL PLANT.

Building Number	1	2	3	4	5	6	7	8	Totals.	Per cent.
Department.										
Machining—										
First Floor	31,000	31,000	31,000							
Gallery	24,000	24,000	24,000	11,000					176,000	100.0
Erecting	9,000	9,000	9,000	4,000		36,000			67,000	38.0
Foundry								121,200		
Sand Floor								19,200	140,400	80.0
Pattern shop	No. 9 22,000								22,000	12.5
Smith Shop					18,000				18,000	10.2
Total of Manufacturing Departments									423,400	241.0
Shipping and Storage				18,000 4,000		3,000			25,000	14.2
Pattern Storage	No. 9 63,000								63,000	35.8
Lumber Storage		No. 10 1,600	No. 11 5,600						7,200	4.1
Engine Room							5,200		5,200	2.9
Boiler Room							4,500		4,500	2.5
Coal Storage							3,000		3,000	1.7
Drawing Room	10,000								10,000	5.7
Office	10,000								10,000	5.7
Total Floor-space under Roof									551,000	313.3

necessary, which is profitable for heavy forge working) should be ample to take care of a 25 per cent increase in the rest of the plant.

A width of 100 feet inside is taken as basis for the wing shops. A gallery 50 feet wide, adjacent to the 50-foot main bay, and 25 feet from the floor, affords good light and ventilation under the gallery. A gallery 10 feet wide projecting into the main bay does not interfere with the placing or operation of the heavy tools and provides a central location for stairways, elevators, wash-rooms, shop offices, tool-rooms, storage, etc., without encroaching on the main gallery floor. With this cross-section, the floor area per unit is 40,000 square feet on the first floor and 24,000 square feet on the gallery, totaling 64,000 square feet, or more than is called for in Table IX for both machining and erecting. Therefore three shops 90 feet in length are assigned to erecting and assembling, which shortens the main erecting shop to about the length of the foundry. A portion of the space in shop No. 4 is assigned to storage and shipping, and also a portion at the south end of the main erecting shop. A width of 204 feet is adopted for the foundry.

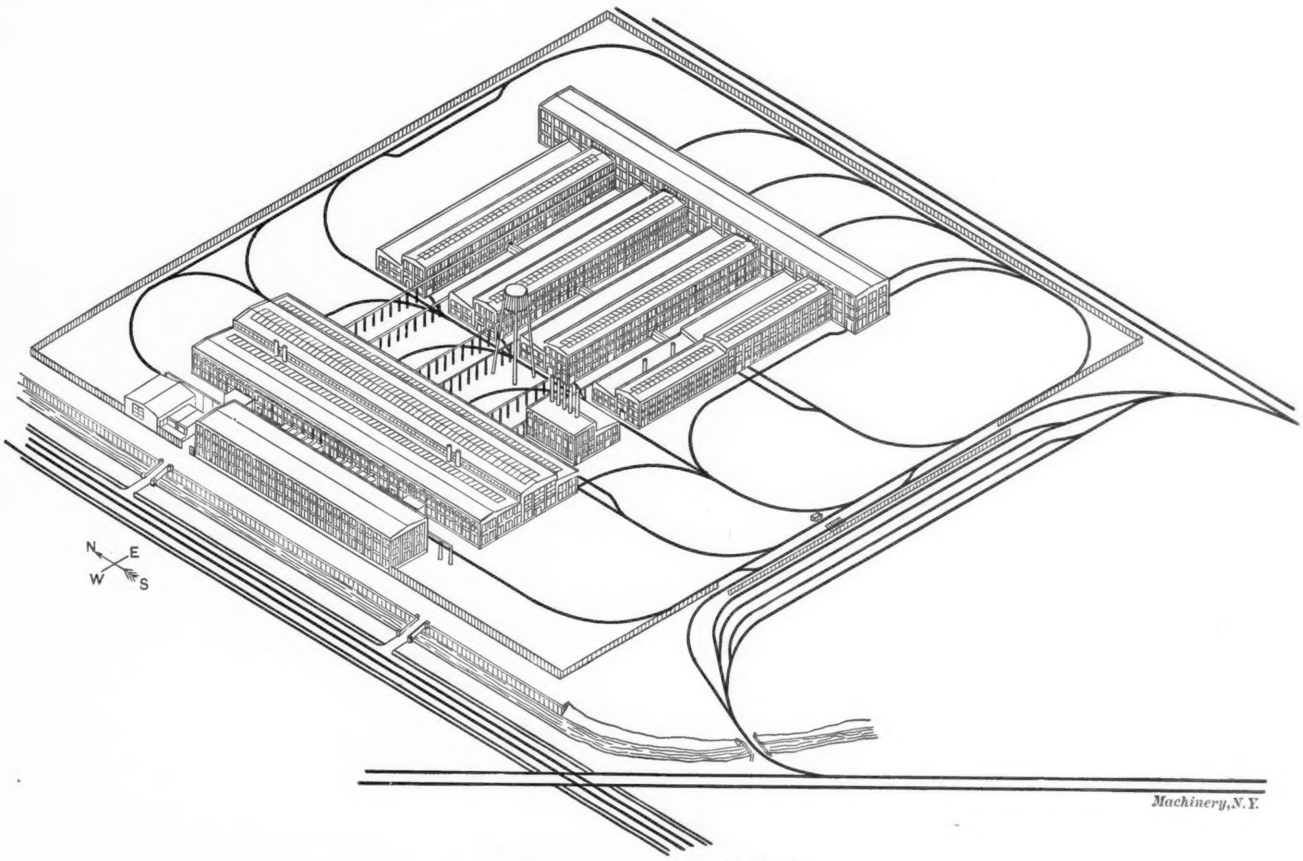


Fig. 27. Perspective of Model Plant

Assuming that 10,000 square feet each would be required by the drafting department and office (from Table VIII), and taking 22,000 square feet for the pattern shop (from Table IX), and 63,000 square feet for the pattern storage (slightly more than given in Table VIII for Plant No. 1), the total of 105,000 square feet is deemed sufficient for these departments. Making one building 80 feet wide and 3 stories high, the length is kept to about 450 feet.

This arrangement provides for the drawing room on the top floor, the offices on the second floor and the pattern shop on the ground floor. These departments will therefore get light from all sides but the south. Lumber storage is provided near the pattern shop and this corner of the works will be relatively free from the smoke of switch-engines and the dirt from the foundry, as the prevailing winds are from the southwest. The direction of the prevailing winds in warm weather should be well considered, and the plant laid out to get the benefit of them, if no more important feature has to be sacrificed by so doing.

Cross-section of Buildings.

The distance from floor to roof truss in the various buildings is determined by the required height of crane rails (distance under the hook is approximately the same), and the clearance required for the cranes themselves. The following table gives clearances sufficient to permit of installing the cranes built by the leading makers.

Capacity.	Span.	Clearance. Rail to Truss.	Rail to Column.
5-ton (Trolley on lower flange of girder.)	33′	2′ 6″	7″
10-ton	50′	6′	8″
15-ton	60′	6′ 6″	10″
20-ton	60′	6′ 6″	10″
30-ton	70′	8′ 6″	12″
40-ton	70′	8′ 9″	12″

The forge shop, Fig. 23, is given plenty of head-room, with swinging windows close to the roof, to provide adequate natural ventilation. Ordinary circular ventilators seem to fail in clearing such a shop of smoke and gases, and monitor louvres, as commonly placed, are not a great deal better.

The velocity of the efflux of the smoke and foul air is governed by the difference in temperatures between the air inside and the air outside. The average temperature in a forge shop is seldom greater than 90 degrees; with the outside temperature at 55 degrees (a yearly average for the Central states), the difference in weight of the two columns of air is so little that the foul air escapes only in a small amount through ventilators in the roof. Even at zero-temperature outside, the velocity of efflux is but slightly greater, as the velocity increases as the square root of the differences in temperatures.

The writer advocates the use of windows near the roof. These windows, when open, allow any horizontal air currents to blow straight through, as even a gentle breeze will have a higher velocity than is obtained through roof ventilators. Heating radiation will of necessity be supplied to make up for the loss of heat from the building. This method of ventilating is provided for all the other buildings, and especially in the boiler room. The air in the shops will be renewed in winter time by the natural filtration of air through the walls, and by the opening of doors. Heating engineers often figure on three changes per hour in large shops on account of these losses.

Central skylights of ribbed glass, in the roofs of the high buildings, will diffuse the direct rays of the sun so that

the workmen will not be seriously bothered. An overhead skylight on a roof within 30 feet of the floor is almost an absurdity, as its effectiveness for lighting must be greatly nullified by painting in order to protect the men from the heat of the direct rays. This, of course, does not apply to saw-tooth skylights.

The headroom of the pattern shop building, Fig. 24, is 20 feet, or one-fourth of the width. This ratio is given by a number of authorities as necessary for good lighting. The rule works out in practice, as may be observed in many instances.

Arrangement of Space—Model Plant.

The following figures are given for comparison with the Table V of the October issue, covering plants already built.

	Square Feet.	Percentage.
Rectangular space bounding buildings, 650 by 1,007 feet, equalling	654,000	100
Covered by buildings	389,000	59.4
Under yard cranes	93,600	14.3
Tracks and vacant space	172,400	26.3
Average haul of castings to shops		500 feet
Maximum distance of electric transmission		700 feet

The layout shown in Fig. 20 permits of the allotment of space for the different departments in close accord with the desired figures of Table IX, as will be seen by comparing Table XI with Table IX.

Allowing space for erecting and assembling in the wing shops has many advantages. Scraping and fitting and group assembling can be done in under the gallery floor, served by light cranes. When the groups are ready for erecting, they can be carried out into the main space by the cranes on the runways projecting into the No. 6 building. This reserves the high shop strictly for its designed and most productive purpose. Then again the portion of the 50-foot bay of the wing shop reserved or allotted to erecting, forms a neutral ground between the machining and erecting departments, and is ready for instant use to accommodate an overflow from either branch of the work. In other words, this space can take care of the surges of forced production, and the common trouble attendant upon the placing of a new and very large tool in a space already overcrowded, is obviated.

Yard Cranes.

The cranes in the yard between the foundry and the pattern storage buildings will handle the charging trucks loaded with pig iron from the storage piles to the outside platforms, which form extensions to the charging floors. The cranes will also handle the heavy flasks and core-boxes between the points of storage and use.

Water Source.

A stream of water, even though the flow is small but steady, is worth a good deal to a large works, as a dam will form a reservoir of a far greater capacity than needed. And the water can flow through the condensers to the lower level of the stream with but little pumping, and also keep the fire-pump primed without a tank.

The block plan Fig. 20 and the isometric view Fig. 27 are self-explanatory, especially to one who has followed the previous papers of this series.

Unless the engineer-in-charge has a large force of tried men and plenty of time, it is much better, in fact, almost necessary, to use the service of an architect on a project of this size. The architect's estimate of cost will check that of the engineer.

The succeeding instalment will cover the data and instructions that would be required to start an architect on the definite plans for the buildings, and will give costs that will form a basis for estimating the many details of works construction.

* * *

An interesting substitute for the ordinary forms of wall paper has, according to the *English Mechanic and World of Science*, been introduced in India, in the form of a damp-proof wall covering made from copper. The material varies in thickness from 0.0012 to 0.006 inch. Apart from its wearing qualities this wall covering is insect-proof, as well as damp-proof, which makes it particularly desirable in India during the rainy season.

HOW TOM CROSSED THE RUBICON.*

A. P. PRESS.

I met Tom the other noon at lunch—that is, he was Tom when I knew him last. He is Mr. Smith now, and he is superintendent of the Laporte Machine Co.; but when we were foremen together at the E. G. Co., he was just plain Tom, and he ran the "West" shop. Tom left the E. G. Co. a long while ago, and I hadn't seen him for years till this week. Monday when I was out at lunch in came Tom, or Mr. Smith, I should have said; he took a seat at the same table with me, and we had a good old talk.

I never knew why he left the E. G. Co., and, as Tom said, he didn't know himself for a long while. As I told you at the start Tom was foreman of the "West" shop for years and he "made good"—so good, in fact, that other firms in the same lines of work wanted him, and they kept making him good offers, and that got him "on the run." Tom didn't seek the jobs, but the jobs came around looking for him. Finally one firm made him an offer of $1,800 a year, and as he was getting only $27 per, he couldn't say "no." He didn't close the deal, but he sent a note up to the "super" that he wanted to leave; "see me on this," was what he got back, and Saturday noon he went up and saw the "super."

"Well, have you crossed the Rubicon yet?" were the first words the "super" said to Tom as he came in the door.

Now, Tom was a good man; he could handle a lathe or a planer, and he could get a lot of good work out of a poor set of men, but he was not strong on Roman history, and though he had heard the name before, he wasn't sure whether it was a river in Asia or whether it was a part of the third degree of the lodge that he had been put through a week before. In fact, he rather thought it was the lodge, so he answered back promptly, "I suppose I have, sir."

"Well," said the "super," "I never like to change the personnel of the foremen, but if it's too late it can't be helped."

He went on and gave Tom a lot of good advice, but not a word did he say about more money; and after he was done Tom went out feeling kind of queer. As he told his wife when he got home, he didn't know whether he had a compliment or a "call down," but the "Old Man" had used him fine, but after he got through he didn't know where he was at.

He went with the Laporte Co. and made good all right, but, as Tom said, "It never came to me till I got hold of an old book on Roman history, what the 'Old Man' meant by 'crossing the Rubicon.'" But as things have turned out I guess it is just as well.

* * *

A dirty line-shaft is a reproach to a shop foreman, and also is a fire hazard, especially in shops where considerable quantities of dust and lint are flying about. Accumulations of fuzz and grease on line-shafts are said to have started fires, and insurance companies in some cases require that the line-shafts be kept clean. The simplest and perhaps most effective method of doing this is by means of straw-board "travelers," which are simply annular disks of straw-board cut with the hole slightly larger than the diameter of the shaft. These disks are cut through from the hole to the exterior on one side so that they may be sprung over the shaft. In the magnificent machine shops of the Western Electric Co., Hawthorne, Ill., the travelers are largely used on the line-shafts, and the sight is somewhat uncanny. Hundreds of them are traveling back and forth all day, doing their work most effectively. The line-shafts are kept bright and perfectly clean of all accumulations, and the general appearance of the shop greatly improved.

*In Roman history "crossing the Rubicon" is the act of Julius Cæsar returning to Italy at the head of his army contrary to the orders of the Roman senate. He was governor of Gaul, and the commanding-general of the Roman army required to keep the province subjugated. His campaign had been a brilliant success, and in its progress he neared the boundary of Italy, where the desire to return to Rome became too strong to be resisted. To return he had to cross the Rubicon, a small river separating ancient Gaul from Italy, and this he could not do as commander of the army without committing treason, but personal desire overcame his patriotic scruples. Cæsar's entrance into Italy at the head of his victorious army caused the downfall of Pompey and the Roman republic, and the rise of the empire, of which he was the first emperor. Hence, "crossing the Rubicon" is a saying applied to any move that may have important consequences to the one making it.

THE WINDSOR MACHINE CO.—EXAMPLES OF ITS SHOP PRACTICE.

As everyone familiar with the machine tool business knows, there is a remarkable trio of machine shops hidden in the narrow valleys of the out-of-the-way State of Vermont. All three of these shops (which are within a few miles of each other, two at Springfield and the other at Windsor) are remarkable for the originality of their methods and their products, and thus give evidence of originality in the men behind them, as well. The writer had the good fortune, on his last visit to that locality, to enjoy there a period of crisp, sunny autumn weather, and it left the inevitable impression on his mind that the brisk Vermont air, and the freedom from the countless distractions of the city, must have a tonic and clarifying effect on the minds of these resident mechanical geniuses.

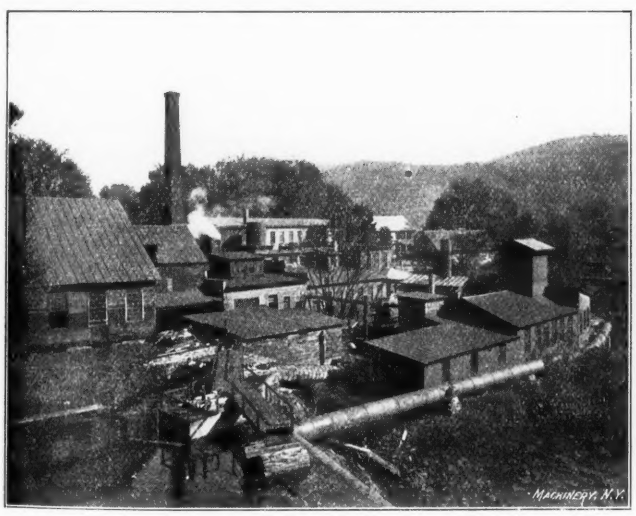
All speculation aside, however, the methods and products of the three shops mentioned will repay the careful study of anyone concerned with the building or using of machine tools. Much has been written about the work of two of these firms—the Jones & Lamson Machine Co., and the Fellows Gear Shaper Co., of Springfield, Vt. Less has been said, however, about the Windsor Machine Co., the third member of this trinity. This is probably due to the fact that, while in point of years it is the oldest of the three, it has only of late years been rejuvenated to the extent of becoming an active factor in the machine tool trade. The following pages, therefore, devoted to a brief description of selected operations taken from the work of their plant, treat of material hitherto unpublished.

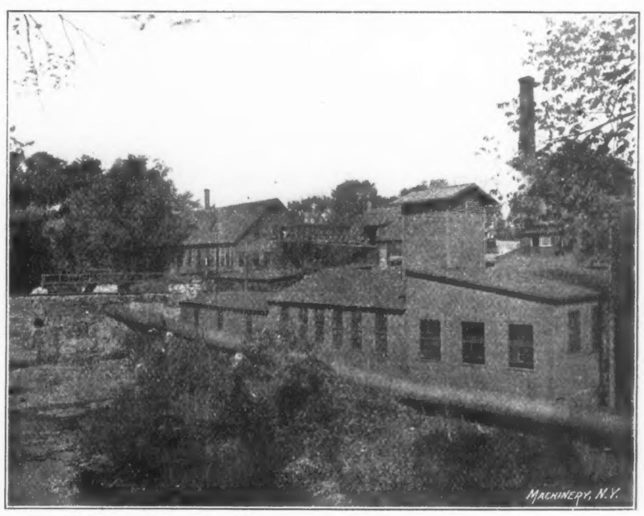
The Town and the Shop.

Windsor is situated on the Connecticut River, about 140 miles from Boston, and 260 miles from New York, with the latter of which cities it has through train service in the summer. It lies in a region which is one of the beauty spots of the globe, and the chosen home of celebrated artists and writers. The salient features of the region, as may be seen from the view of the town shown above, are the winding Connecticut River, with its fertile, tree-shaded valley, and "blue Ascutney looking down" over its foot-hills from the westward. The roomy, old-fashioned mansions and story-and-a-half cottages of the town are fairly hidden in the great elms for which this valley is famous, and would make little showing in the picture, had it not been taken in the spring before the trees leaved out.

The shop gives plain evidence of having grown by gradual accretion from almost infinitesimal beginnings. It stretches

Fig. 1. The Home of the Gridley Turret Lathe; the Town of Windsor, the Connecticut River, and Mount Ascutney.





Figs. 2 and 3. Shops of the Windsor Machine Co. This Plant, like Topsy, was not born, but "just growed."

along the bank of Mill Brook, which comes tumbling down through the town from the hills in the rear (the reader must not judge of the "tumbling" from the picture, which was taken in a dry time), parting with its energy, as it goes, to the succession of water wheels with which the thrifty inhabitants have checked the precipitancy of its course. One of these turbines helps to drive the line shafting of the Windsor Machine Co., in times of normal rainfall. For the past few months, however, the work has fallen entirely on the Brown engine and the Sturtevant engine-dynamo set, which are needed even under normal conditions to help out the water power.

The Product of the Windsor Machine Co.

The Windsor Machine Co. makes the Gridley automatic turret lathes or screw machines. The single spindle form of this machine has been on the market for some years, and may be seen at work in almost any part of the screw-machine-using world. The four-spindle automatic design belongs to a more recent period, and was described for the first time in the department of "New Machinery and Tools" in the February, 1908, issue of MACHINERY, where the ingenious and original features of its construction were explained in detail and illustrated in a number of engravings. It will be remembered that the salient feature of the design of that machine was the construction of the spindle head, shown in Fig. 4. This has a bearing in the one-piece frame of the machine on the outside diameter of the spindle flanges, and on the journal formed on its shank, thus holding it firmly in alignment.

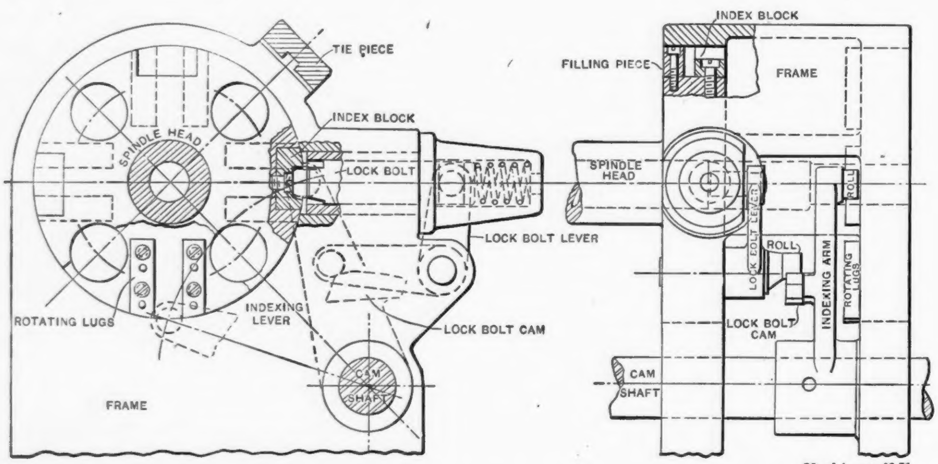


Fig. 4. Sketch showing the Spindle Head and the Indexing and Locking Mechanism.

Still more important than this item, in the vital task of preserving the alignment of the four spindles, is the mounting of the four-sided tool-holder on the solid shank of this revolving head, thus preserving the proper relations of the tools and the spindles even in the scarcely possible case of serious wear of the head in the frame. This feature, together with the locking of the head and the guiding of the sliding tool-holder, at radial distances considerably greater than the radius of the circle in which the spindles revolve, gives a construction it is difficult to criticise, off hand.

In this, as in any other multiple spindle screw machine, the important point in the building of the machine, so far as accuracy is concerned, is the location of the spindle holes and of the indexing blocks in the revolving head. In a single spindle machine, if the index ring of the turret is not exactly divided, the machine may still be made to do its work accurately, as the holes in the turret may still be bored to line exactly with the spindle in each position. In a multiple spindle machine, however, if the spindle head is not exactly divided, there is no possibility of accurate work. The tool-holder may be machined to line up with the spindle in one position, but when the head is indexed to the next position, this coincidence is lost beyond recovery. On account of this necessity for extreme accuracy, the machining of the spindle head will be described from start to finish, in the following paragraphs, being chosen as a representative piece of work, and one capable of testing the mettle of the most skilled mechanic.

Lathe Operations on the Spindle Head.

The first machine operation on the cast-iron spindle head, is that of boring and reaming the central hole. This is done in the lathe shown in Fig. 5. The operator of the lathe took the greatest pleasure imaginable in explaining each step of this operation to the writer. He hustled around and brought

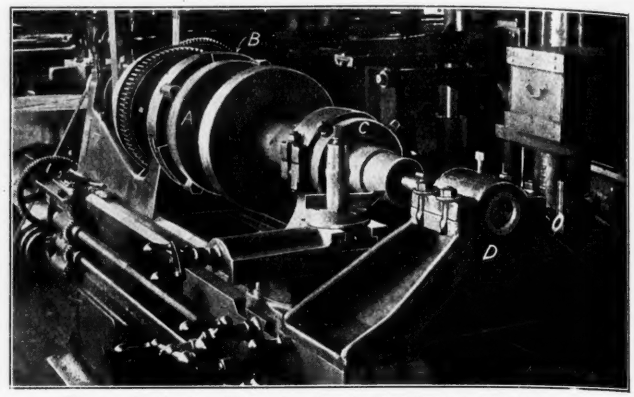


Fig. 5. Boring and Reaming the Central Bushing Hole in the Spindle Head.

out one special tool after another, pausing after the explanation of each step only long enough to get a fresh breath, and, with a prefatory "now then," start off on the next lap. His enthusiasm is by no means unmatched among the machinists of these country towns, and is in marked and refreshing contrast with the time-serving spirit found among the workmen in large industrial centers. But perhaps these more sophisticated, city-trained workmen are not entirely to blame for their unsatisfactory attitude.

The lathe carried a four jaw, independent chuck *B*, with a central bushing for supporting a boring-bar, as will be described later. The large end of the casting *A* is grasped and centered in this chuck, and the shank is rapped until it runs very nearly true. Then the revolving steady rest or "cat head" *C*, is pushed on over the shank, and the eight screws of the revolving bushing are set down gently on the work, after which a light chip is taken with an ordinary turning tool for an inch or so from the end of the shank. Then the screws in bushing *C* are released, and a test indicator is applied to the turned portion. If, as is almost invariably the case, the work runs out a trifle, the shank is rapped until the indicator shows a true running surface. Then the bushing screws are set down again, and the indicator is applied for a second time to see that the surface still runs true. All this is simply to make sure that the work is supported in an unstrained condition.

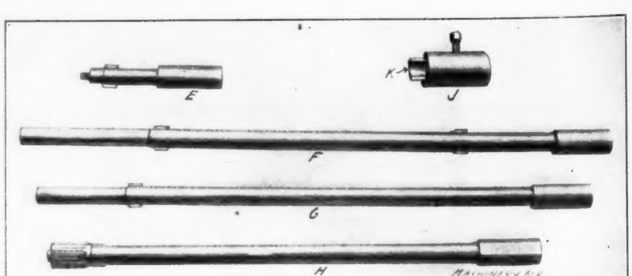


Fig. 6. Boring-bars, Reamers, etc., used in the Operation shown in Fig. 5.

To the wings of the carriage is bolted the heavy boring tool support *D*. In the first boring operation, this carries the short, stiff boring tool *E* (see Figs. 5 and 6). As may be seen in Fig. 4, the bore of the head is cored out to form an unfinished recess for the greater part of its length, leaving finished seats at either end for the "Lumen" bushings which

support the driving shaft. It is the work of this stiff boring tool E to rough bore the outer bushing seat at the shank end.

In the next operation, boring-bar F (see Fig. 6) is used. This has a pilot shank which fits in the hardened bushing in the chuck, and it carries two cutters—one for finish boring the outer or shank end of the hole, and the other for simultaneously rough boring the inner seat. The next bar G finish bores the inner seat, being steadied by the pilot which bears in the bushing in the chuck, as before.

The next operation is rough reaming. For the outer end, the shank of long reamer H is grasped at a point near the business end in the support D. For this purpose, bushing J is inserted in the support, along with half bushing K, down onto which the reduced stem of the reamer is held and seated by the set-screw. For rough reaming the further end, the half bushing is withdrawn, and the reamer is pulled out to its full length, so that its regular shank, seated in bushing J, is held in support D. At the conclusion of this operation, the work is removed from the machine, and the holes are finish reamed from either end by hand.

The head is now ready for the turning operations. Hardened plugs, ground so as to be very nearly absolutely true with their centers, are driven into the reamed holes from either end. The plug at the shank end has a notch cut in it

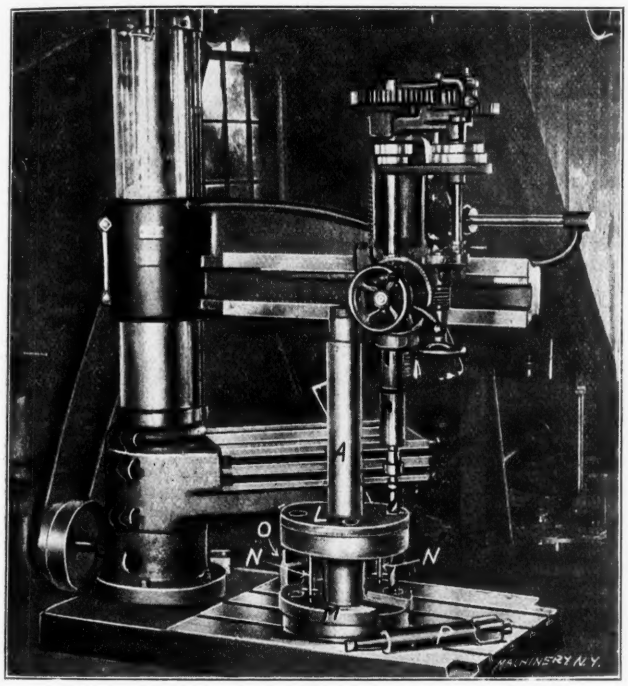


Fig. 7. Roughing Out the Spindle Holes in the Radial Drill by Drilling and Counterboring.

which furnishes a seat for a bar, which, when hammered on the other end, serves to remove the plug. The plug at the head end is knocked out, in the obvious way, with a bar passing through the bore. Mounted on the centers in these plugs, the exterior of the head is finished all over in the lathe to accurate dimension, except on the outside diameters of the shank and of the two flanges. These are left large, to be finished by grinding. The threading at the end of the shank is also done at this time.

Boring the Spindle Holes.

The next, and the crucial operation, is the boring of the holes in the head for the spindle bushings. These holes are first rough bored under the radial drill. This operation is shown in Fig. 7. A jig is used which consists of two plates, L and M, the first fitting around the shank of the head, and dropped down over it to rest on the top of the upper flange, as shown, while the lower plate M is slotted through to the center to permit being slipped sidewise into position. Plate M is provided with a lip all around, which fits down over the periphery of the lower flange, and thus centers itself. It is clamped in position by two studs N with cross pin handles, which are screwed up against the bottom of the upper flange. A tongue O, screwed to M, enters a groove in L, and thus lines up the two members.

In this operation the long drill shown in place is first run down through the bushing in L and on through the upper flange, down into the bushing in M, and so through the lower flange, for each of the four holes. Then plates L and M are removed, and the drill is replaced with counterbore P, which clears the holes out to within 1/16 inch of their finished diameter.

After this, the heads are taken to the grinding machine, and finished very accurately on the outside diameters of the

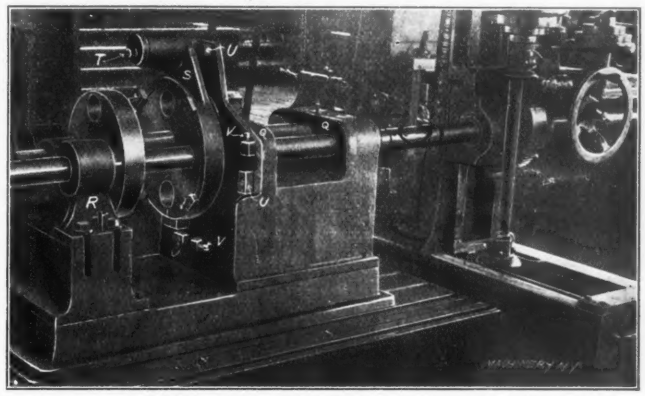


Fig. 8. Finish Boring the Spindle Holes in an Accurate Indexing Jig.

flanges and the shank, to insure accurate fitting in the subsequent jigs and in the final resting place in the frame of the machine. The reason for rough boring the holes before grinding is to prevent the possibility of bulging out, by the boring, the thin wall of metal between the holes and the finished edge of the flange.

After the grinding, the holes are accurately bored by the method shown in Fig. 8. The jig shown, mounted on the table of a Beaman & Smith boring machine, is provided with accurately sized journals at Q and Q, into which the shank of the head is slipped, bushing holder R being swung back out of the way for the purpose. On the inner flange of the head is clamped the dog S, in whose tail is seated at T a closely fitted, floating plunger, whose opposite sides are milled off flat on the projecting end. On the face of the jig are located four blocks, three of which are seen at U, U, and U, and four set-screws V. The flatted end of plunger T is pushed in between each of blocks U and set-screws V, in turn, and is clamped against the former by the latter. This is the means provided for indexing the work accurately to four positions.

Although the jig has bushings on both sides of the center line for boring-bars, as shown, only those on the front are used, the rough boring being done under the radial drill, as described. The boring bar is driven from the spindle of the machine through a universal joint, the bushings in R and Q

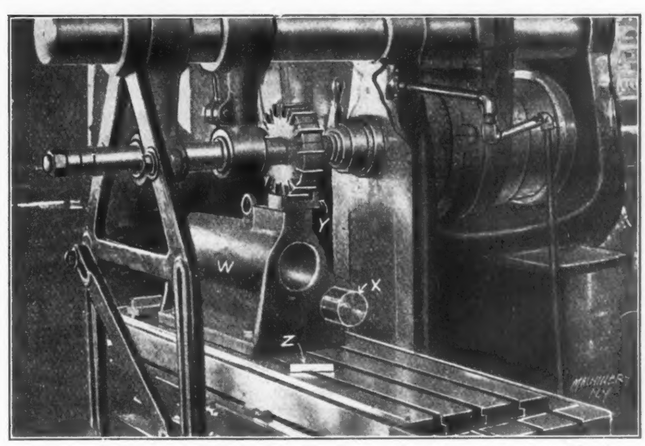


Fig. 9. Setting the Mill for Cutting the Slots for the Indexing Blocks, using a Gage fastened to the Fixture.

being depended on entirely to control the alignment. Holder R, which swings back to permit changing the work, is located in its working position by an accurately-fitted dowel pin and suitable bolts.

Of course, the efficacy of the jig depends on the accuracy of the indexing, and this depends on the spacing of blocks U. In making the jig, these were first located by measurement as nearly right as possible, and then their faces were ma-

chined, and finally scraped to the proper dimension. This final fitting was done by actually boring a piece of work in the jig, and calipering the distance from one hole to the next, all around, until the scraping of the block brought the indexing to the required degree of accuracy.

Milling the Slots for the Indexing Blocks.

The position of the spindles being thus located by the operation just described, it is next necessary to locate the indexing blocks for the spindle bushing holes. These blocks, as may be seen in Fig. 4, are fitted in slots milled in the periphery of the inner flange of the head. They are

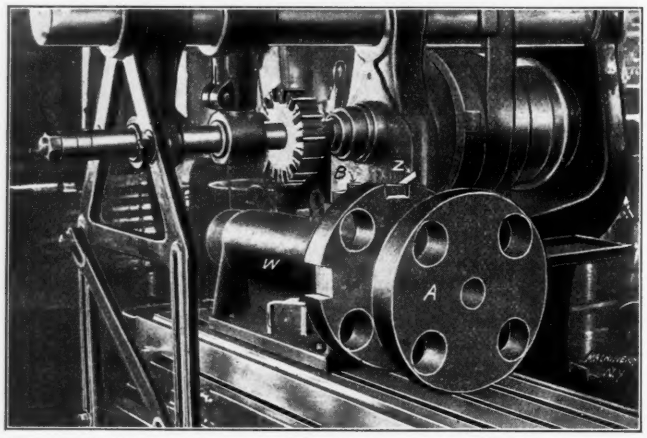


Fig. 10. Testing the Accuracy of the Slots in the Indexing Blocks, using a Test Block fastened to the Fixture.

hardened and ground all over, and are provided with a milled groove having one straight and one taper face, fitting corresponding surfaces on the locking bolt. The straight face is the locating surface, the taper merely furnishing the means for forcing the straight face against the bolt. In making the blocks, the width and the straight side of the slot are carefully sized; this insures accurate indexing if the slots in the head are a good fit for the block, and if they are properly located with reference to the spindles. These requirements are attended to in the operation illustrated in Figs. 9 and 10.

On the table of the milling machine is clamped a fixture *W*, having a hole bored through it to accurately fit the ground shank of the work. At *X* is a plunger of the proper diameter and properly located, to closely fit the spindle bushing holes bored in the head. In a groove milled in the top of the fixture is located, by a closely fitting tongue, the setting gage *Y*. This gage has a groove of the exact depth desired for the groove in the work, but is wider on each side of the cutter by an amount equal to the thickness of the hardened "feeler" *Z* shown lying on the table. Two cuts are taken through the

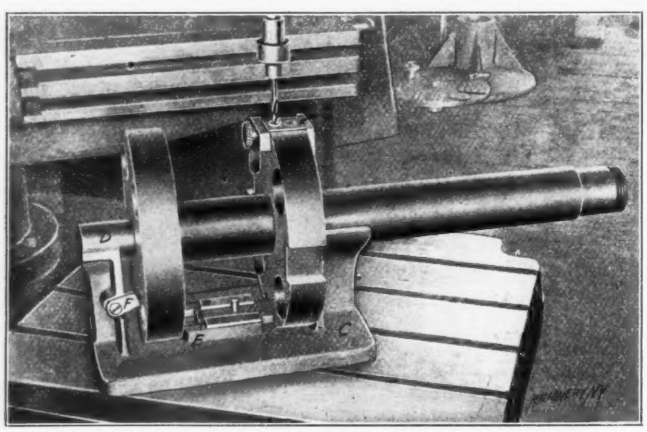


Fig. 11. Drilling the Screw Holes for Holding the Indexing Blocks and the Filling Pieces.

slots, the first with a cutter a few thousandths narrower than the required width and the second with a cutter of a thickness to exactly finish the slot to dimensions. The cutters are set for depth by raising the table until the revolving teeth just barely bite a tissue paper strip laid on the bottom of the groove in *Y*. The centering of the cutter is effected by the use of feeler *Z*, which must lie with equal freedom on each side, between the teeth of the roughing mill and the side of the slot in *Y*, and must just fit on each side, in the same position, for the finishing mill. The work is held in place by locating plunger *X*, and by a nut screwed into the threaded shank of the work, which brings the flange up against the face of the fixture.

After each groove is cut through with the finishing mill, it is tested as shown in Fig. 10. The setting gage *Y* of the preceding illustration is replaced with a testing gage *B*, which fits in the same groove in the top of fixture *W*. It is provided with a projecting block, which enters the finished slot, and is of such width that the feeler *Z* (the same as shown in Fig. 9) should just fit on each side between the block and the sides of the milled groove. The advantage of using the feeler instead of having block *B* fill the slot, is obvious. Block *B*, under the former conditions, might be pushed along its groove until it entered the slot in the work, but if it met with a slight resistance so that it had to be jammed in, it might be quite difficult to tell on which side the interference occurred. With the feeler, this difficulty disappears.

Final Drilling Operations.

The head has next to be drilled for the screws and dowels which hold the indexing blocks in the slots. For this operation, as shown in Fig. 11, a plug *D* is driven into the flanged end of the work, which is laid in half round bearings in the fixture *C*, resting on this plug and on the ground shank. In

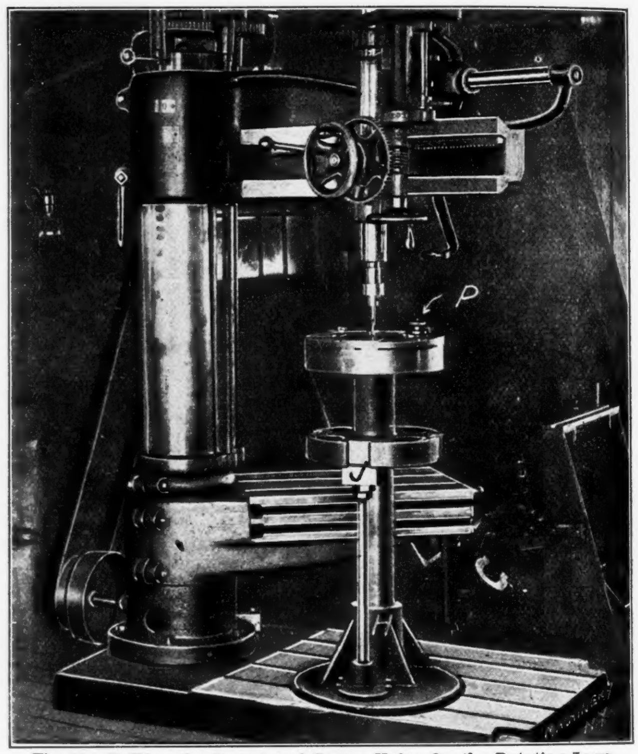


Fig. 12. Drilling the Dowel and Screw Holes for the Rotating Lugs.

the base of the fixture a block *E* is mounted, which slides into that one of the index slots which happens to be lowermost at the time; this locates the work. Latch *F* is swung around against the face of the flange and keeps the piece from shifting endwise.

All of the fixture, as so far described, is used simply for holding the work, and presenting it properly to the drill. The jig proper is seen at *G*. As shown, it consists of a hardened block which fits closely into the slot in the work, and is clamped there by the strap and thumb-screw shown. The holes in this block guide the drill in locating the holes in the work. Besides the screw for the index block, a screw hole for the filling piece shown in Fig. 4 is provided for.

The final operation is that of drilling holes for the screws and dowels which hold the rotating strips seen in Fig. 4. As shown in the engraving, the head is indexed periodically by a roller on the end of a revolving indexing arm, which enters the space between two rotating strips at each revolution, and thus rotates the head after the manner of the well-known Geneva stop motion.

The arrangement for drilling the holes for these rotating strips is shown in Fig. 12. The shank of the head is set into the flanged base *H*, and is supported under the drilling

by the jackscrew arrangement seen at J. The jig proper is shown separately in Fig. 13. It consists of a plate K, carrying hardened bushings for the various holes to be drilled, and located by two plugs L and M, the first of which enters the central hole, while the other sets into one of the spindle holes. This plug M is provided with a pair of oppositely disposed radial plungers, one of which is seen at O. These are normally kept pressed in by a semi-circular spring snapped into the groove shown around the plug, but they may be forced out by a cone which presses against their inner ends, and is operated by the knurled knob P (see Fig. 12). When the jig has been set with plug L in the central hole and M in one of the spindle holes, and with plungers O pressed against the sides of the hole by the screwing up of nut P, the work is ready, as shown in Fig. 12, for drilling the screw and dowel holes.

While the strips are located on the inner face of the flanges, the drilling has, perforce, to be done from the outer side. This means that the holes must be put through very straight indeed. To accomplish this, the work is first spotted by a drill the full diameter of the bushing, and then a small drill is put clear through, followed by two successively larger ones, until finally the hole is cleaned out by a bit of the full diameter required. This gives holes so straight that the dowels

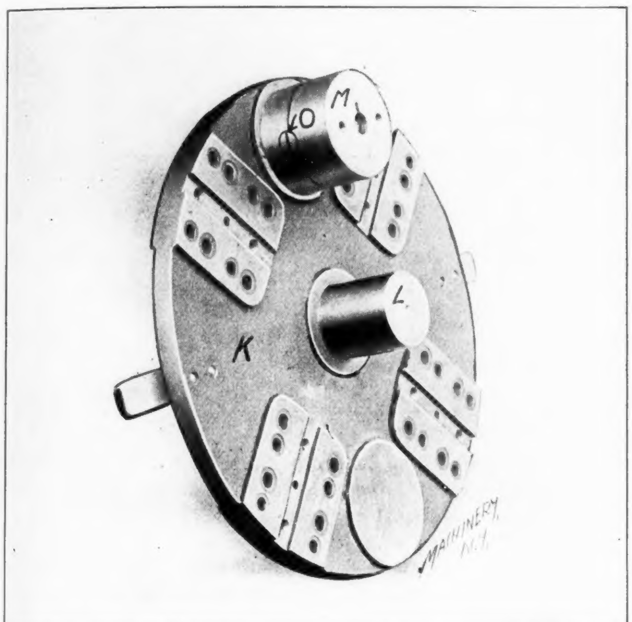


Fig. 13. Bushing Plate for the Drilling Operation shown in Fig. 12.

fit accurately into the jig drilled holes in the strips of the opposite side. This operation completes the machining of this most important member of the Gridley four-spindle automatic screw machine.

While the photographs from which the accompanying halftones were made were not, in themselves, as may easily be seen, examples of the highest order of photographic art, the taking of them was no mean achievement. As was intimated in the beginning, the business of the Windsor Machine Co. has grown so gradually from such small beginnings, that the arrangement of the buildings leaves much to be desired. As a consequence, the place is crowded with machinery, so arranged that progress through the plant is slow and painful for a stranger. The difficulties of taking photographs may be imagined when it is stated that Figs. 9 and 10 were taken with the camera out in the yard, and pointed in through an open window. In other cases the camera tripod was precariously perched on planer tables or piles of castings, and at times it would have been convenient could the acrobatic local photographer have hung by his toes from the line shafting, like a bat.

It is probable that the firm will build new shops down by the railroad track, before many months. If these shops are built, and if as much ingenuity goes into their construction and operation, as into the doing of work in their present confined quarters, they will be well worth visiting and describing.

R. E. F.

JIGS AND FIXTURES—8.

EINAR MORIN.*

DESIGN OF CLOSED JIGS.

In the sixth and seventh installments of this series, the subject of the design of open drill jigs has been dealt with. In the present installment it is proposed to outline the development of the design of closed or box jigs.

We will assume that the holes in the piece of work, as shown in Fig. 83, are to be drilled. Holes A are drilled straight through the work, while holes B and C are so-called "blind holes," drilled into the work from the opposite sides. As these holes must not be drilled through, it is evident that the work must be drilled from two sides, and the guiding bushings for the two blind holes must be put in opposite sides of the jig. The simplest form of jig for this work is shown in Fig. 84. The piece of work D is located between the two plates E, which form the jig, and which, if the jig be small, are made of machine steel and case-hardened. If the jig is large these plates are made of cast iron. The work D is simply located by the outlines of the plates, which are made to the same dimensions, as regards width, as the work itself. The plates are held in position in relation to each other by the guiding dowel pins F. These pins are driven into the lower plate and have a sliding fit in the upper one. In some cases, blocks or lugs on one plate would be used to fit into a slot in the other plate instead of pins. These minor changes, of course, depend upon the nature of the work, the principle involved being that some means must be provided to prevent the two plates from shifting in relation to each other while drilling. The whole device is finally held together by clamps of suitable form. The holes A may be drilled from either side of the jig, as they pass right through the work, and the guides for the drills for these holes may, therefore, be placed in either plate. Opposite the

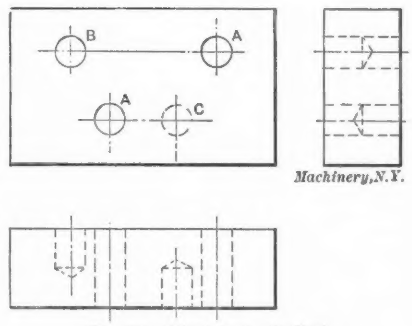


Fig. 83. Work to be Drilled.

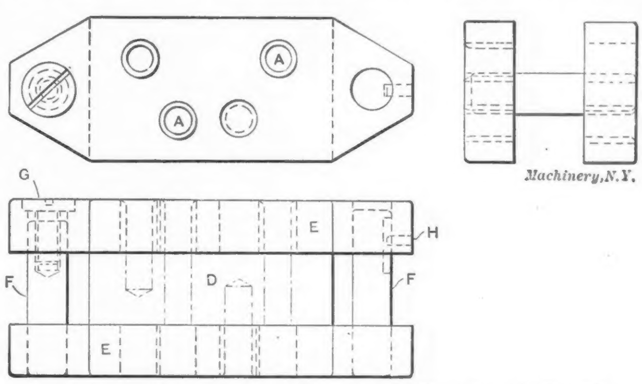


Fig. 84. Simplest Form of Closed Jig for Drilling Work in Fig. 83.

bushings in either plate a hole is drilled in the other plate for clearance for the drill when passing through, and for the escape of the chips.

The two plates should be marked with necessary general information regarding the tools to be used, the position of the plates, etc., to prevent mistakes by the operator. It is also an advantage, not to say a necessity, to use some kind of connection between the plates in order to avoid mistakes, such, for instance, as the placing of the upper plate in a reversed position, the wrong pins entering into the dowel pin holes. This, of course, would locate the holes in a faulty position. Besides, if the upper plate be entirely loose from the lower, it may drop off when the jig is stored, and get mixed up with other tools. Some means of holding the two parts together, even when not in use, or when not clamped

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down on the work, should therefore be provided. Such a means is employed in Fig. 84, where the screw *G* enters into the guiding dowel pin at the left, and holds the upper plate in place. A pin *H*, fitting into an elongated slot in the dowel pin as shown at the left, could also be used instead of the screw. The design shown presents the very simplest form of box jig, consisting, as it does, of only two plates for holding the necessary guiding arrangements, and two pins or other means for locating the plates in relation to each other.

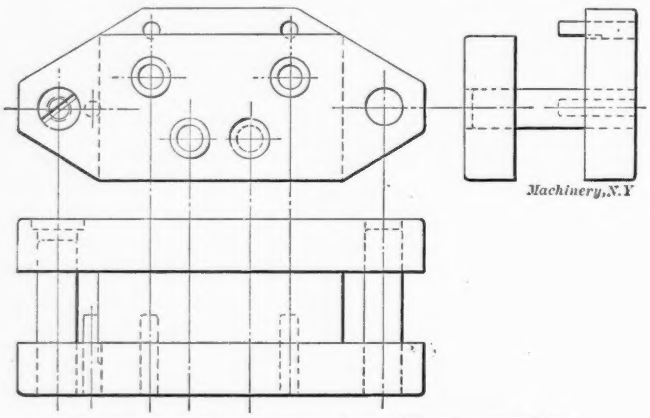


Fig. 85. Jig in Fig 84 Improved by adding Locating Pins.

In manufacturing where a great number of duplicate parts would be encountered, a jig designed in the simple manner shown in Fig. 84 would, however, be wholly inadequate. The simplest form of a jig that may be used in such a case would be one where some kind of locating means are employed, as indicated in Fig. 85, where three pins are provided, two along the side of the work and one for the end of the work, against which the work may be pushed up, prior to the clamping together of the two jig plates. In this figure the jig bushings are not shown in the elevation and end view, in order to avoid confusion of lines. The next improvement to which this jig would be subject would be the adding of walls at the end of the jig and the screwing together of the upper and lower plate, the result being a jig as shown in Fig. 86.

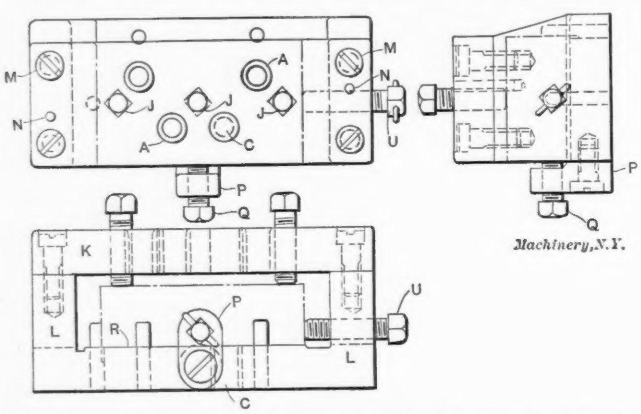


Fig. 86. Further Improvements in Jig, suiting it to Manufacturing Purposes.

This design presents a more advanced style of closed jig, and one of a type which could be recommended for manufacturing purposes. While the same fundamental principles are still in evidence, we have here a jig embodying most of the requirements necessary for rapid work. This design provides for integral clamping means within the jig itself, this being provided in this case by the screws *J*. The upper plate *K* is fastened to the walls of the lower plate *L* by four or more screws *M*, and two dowel pins *N*. The cover *K* could also be put on, as shown in Fig. 87, by making the two parts a good fit at *O*, one piece being tongued into the other. This gives greater rigidity to the jig. In this jig, also, solid locating lugs *F* are used instead of pins.

Referring again to Fig. 86, by having a swinging arm *P* with a set-screw *Q* provided, the work can be taken out and can be inserted from the side of the jig, which will save making any provisions for taking off or putting on the top cover for every piece being drilled. If there is enough clearance between the top cover and the piece being drilled, the screw *Q* could, of course, be mounted in a solid lug, but it would not be advantageous to have so large a space between the top plate and the work, as the drill would have to extend unguided for some distance before it would reach the work. The set-screws *Q* and *U* hold the work against the locating points, and the set-screws *J* on the top of the jig, previously referred to, hold the work down on the finished pad *R* on the bottom plate. These screws also take the thrust when the hole *C* is drilled from the bottom side. It is rather immaterial on which side the bushings for guiding the drills for the two holes *A* are placed, but by placing them in the cover rather than in the bottom plate, three out of the four bushings will be located in the top part, and when using a multiple spindle drill, the face *R* will take the larger thrust, which is better than to place the thrust on the binding screws *J*. In the designs in Figs. 86 and 87 the whole top and bottom face of the jig must be finished, or a strip marked *f* in Fig. 88, at both ends of the top and bottom surfaces, must be provided, so that it can be finished, and the jig placed on parallels *D* as illustrated.

While the jig itself, developed so far, possesses most of the necessary points for rapid production and accurate work,

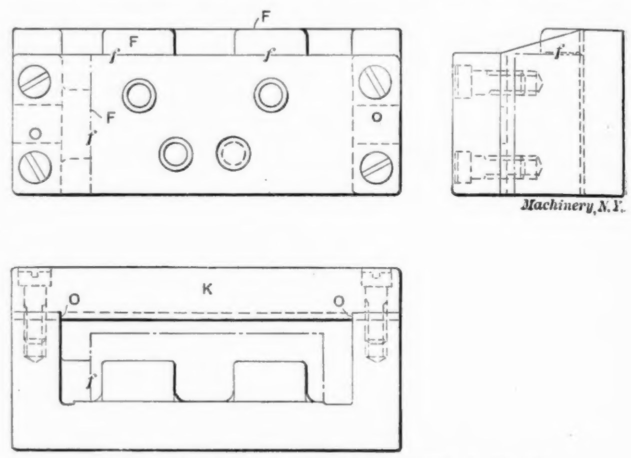


Fig. 87. Alternative Design of Jig shown in Fig. 86.

the use of parallels, as indicated in Fig. 88, for supporting the jig when turned over so that the screw heads of the clamping screws point downward, is rather unhandy. Therefore, by adding feet to the jig, as shown in Fig. 89, the handling of the jig will be a great deal more convenient. The adding of the protruding handle *S* will still further increase the convenience of using the jig. The design in Fig. 89 also presents an improvement over that in Fig. 86 in that besides the adding of feet and handle, the leaf or strap *E* is used for holding screw *Q* instead of the arm *P*. This latter is more apt to bend if not very heavy, and would then bring the set-screw in an angle upwards, which would have

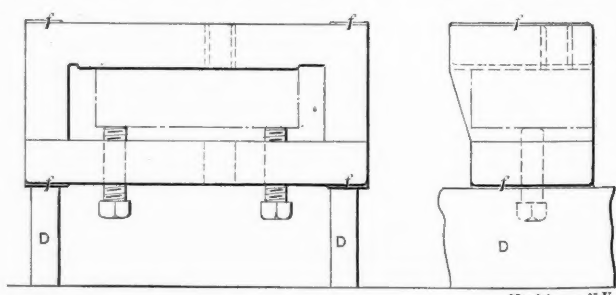


Fig. 88. Showing use of Jig in Fig. 86 in Combination with Two Parallels.

a tendency to tilt the work. The strap can be more safely relied upon to clamp the work squarely. Two set-screws *J* are shown for holding the work in place. The number of these set-screws, of course, depends entirely upon the size of the work and the size of the holes to be drilled. Sometimes one set-screw is quite sufficient, which, in this case, would be placed in the center, as indicated by the dotted lines in Fig. 86.

The type of jig shown in Fig. 89 now possesses all the features generally required for a good jig, and presents a

type which is largely used in manufacturing plants, particularly for fairly heavy work. The jig shown in Fig. 90, however, represents another type, somewhat different from the jig in Fig. 89. The jig in Fig. 89 is composed of two large separate pieces, which, for large jigs, means two separate castings, involving some extra expense in the pattern-

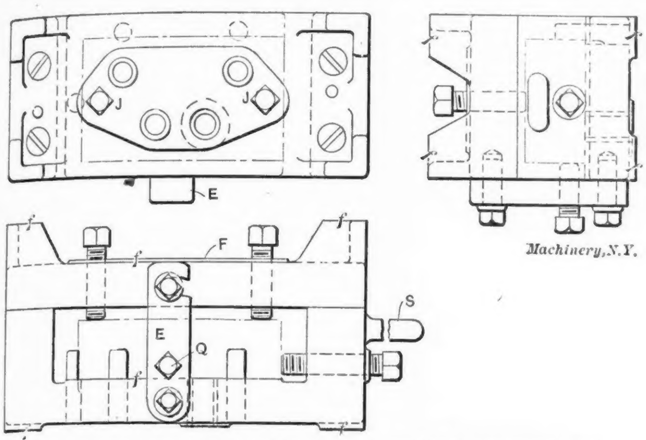


Fig. 89. Jig Improved by adding Feet Opposite Faces containing Drill Bushings.

shop and foundry. The reason for making the jig in two parts, instead of casting it in one, is because it makes it more convenient when machining the jig. The locating points, however, are somewhat hidden from view when the piece is inserted. The jig shown in Fig. 90 consists of only one casting *L*, provided with feet, and resembles an open drill jig. The work is located in a manner similar to that already described, and the leaf *D*, wide enough to take in all the bushings except the one for the hole that must be drilled

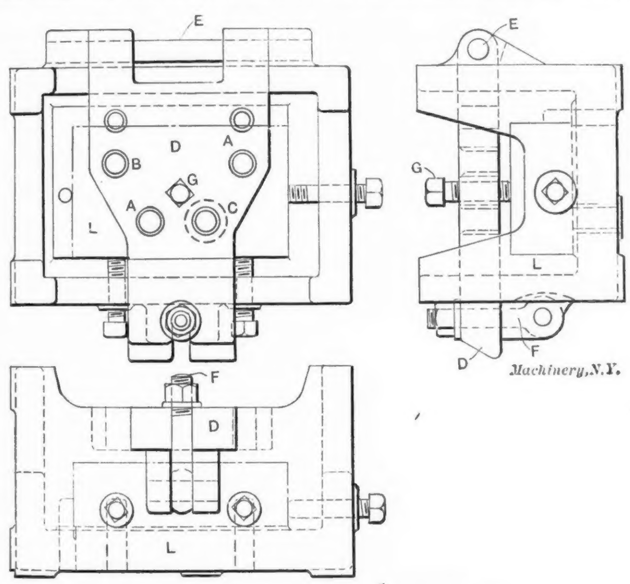


Fig. 90. Alternative Design of Jig in Fig. 89.

from the opposite side, is fitted across the jig and given a good bearing between the lugs in the jig wall. It swings around the pin *E*, and is held down by the eye-bolt *F* with a nut and washer. Sometimes a wing-nut is handier than a hexagon nut. Care should be taken that the feet reach below the top of the nut and screw. The set-screw *G* holds the work down, and takes the thrust when the hole from the bottom side is drilled. The three holes *AA* and *B* are drilled from the top so that the thrust of the drilling of these three holes will be taken by the bottom of the jig body *L*. If one set-screw *G* is not sufficient for holding the work in place, the leaf may be made wider so as to accommodate more binding screws.

It should be mentioned here, however, that it is an objectionable feature to place the clamping screws in the bushing plate. If the leaf has not a perfect fit in its seats and on the swiveling pin, the screws will tilt the leaf one way or another, and thus cause the bushings to stand at an angle with the work, producing faulty results. In order to avoid this objectionable feature, a further improvement on the jig, indicated in Fig. 91, is proposed. In the jig body, the locating points and the set-screws which hold the work against the locating pins are placed so that they will not interfere with two straps *G*, which are provided with elongated slots, and hold the work securely in place, also sustaining the thrust from the cutting tools. These straps should be heavily designed, in order to be able to take the thrust of the multiple spindle drill, because in this case all the bushings except the one for hole *B* are placed in the bottom of the jig body. The leaf is made narrower and is not as heavy as the one shown in Fig. 90, because it does not, in this case, take any thrust when drilling, and simply serves the purpose of holding the bushing for hole *B*. The leaves and loose bushing plates for jigs of this kind are generally made of

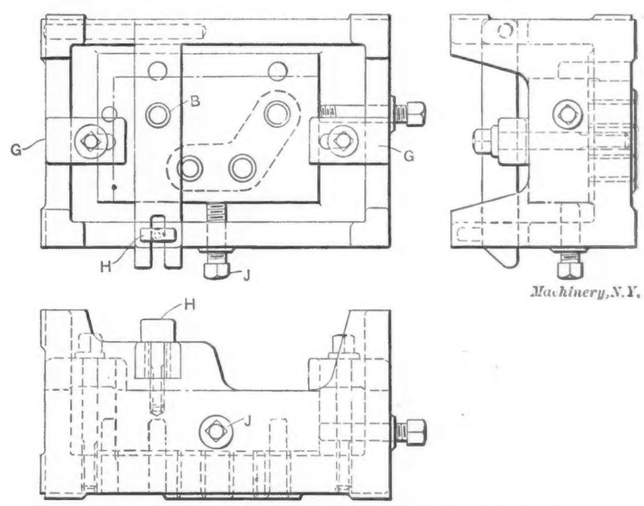


Fig. 91. Jig where Thrust of Drilling Operation is taken by Clamps.

machine steel, but for larger sized jigs they may be made of cast iron. The leaf in Fig. 91 is simply held down by the thumb screw *H* of a type as shown in Fig. 48 in the July installment of this series.

If the hole *B* should be near to one wall of the jig, it may not be necessary to have a leaf, but the jig casting may be made with a projecting lug *D*, as shown in Fig. 92, the jig otherwise being of the same type as the one illustrated in Fig. 91. The projecting part *D*, Fig. 92, is strengthened, when necessary, by a rib *E*, as indicated. Care must be taken that there is sufficient clearance for the piece to be inserted and removed. Once in a while it happens, even with fairly good

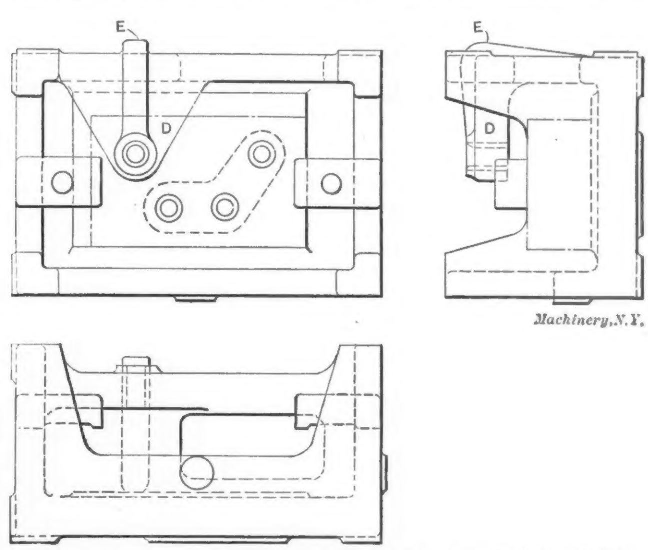


Fig. 92. Modification of Jig in Fig. 91, which practically brings it into the Class of Open Drill Jigs.

jig designers, that an otherwise well-designed jig with good locating, clamping, and guiding arrangements, is rendered useless for the simple reason that there is not enough clearance to allow the insertion of the work. The jig shown in Fig. 92 resembles, in reality, an open jig more than a closed jig.

Fig. 93 shows the same jig as before, but with the additional feature of permitting a hole in the work to be drilled from the end and side as indicated, the bushings *E* and *F*

being added for this purpose. It will be noticed that the bushings in this case extend through the jig wall for some distance, in order to guide the drill closely to the work. Bosses may also be cast on the jig body, as indicated by the dotted lines, to give a longer bearing for the bushings.

Feet or lugs are cast and finished on the sides of the jig opposite to the bushings, so that the jig can be placed conveniently on the drill press table for drilling in any direction. It will be noticed that when drilling the holes from the bushings *E* and *F*, the thrust is taken by the stationary locating pins. It is objectionable to use set-screws to take the thrust, although in some cases it is necessary to do so. When designing a jig of this type, care must be taken that strapping arrangements and locating points are placed so that they, in no way, will interfere with the cutting tools or guiding means. In this case the strap *H* is moved over to one side in order to give room for the bushings *F* and the set-screw *K*. Strap *G* should then be moved also, because moving the two straps in opposite directions still gives them

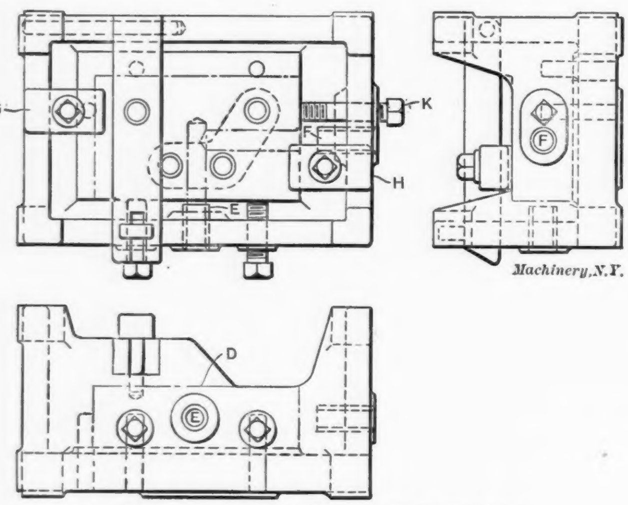


Fig. 93. Jig for Drilling Holes from Two Directions.

a balanced clamping action on the work. If the strap *G* had been left in place, with the strap *H* moved sideways, there would have been some tendency to tilt the work.

Sometimes one hole in the work comes at an agle with the faces of the work. In such a case the jig must be made along the lines indicated in Fig. 94, the feet on the sides opposite to where the drill bushings are placed being planed so that their faces will be perpendicular to the axis through

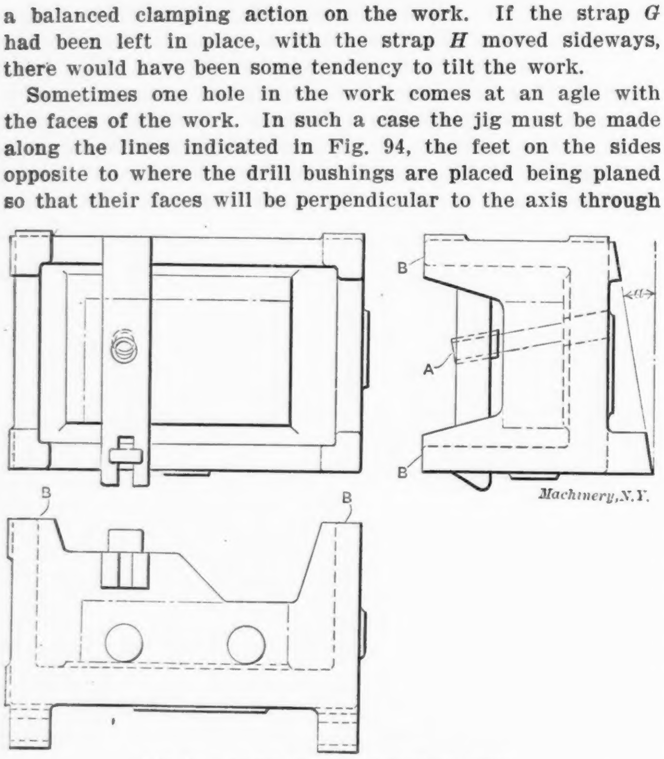


Fig. 94. Jig for Drilling Holes at an Angle.

the hole *A*. This will, in no way, interfere with the drilling of holes which are perpendicular to the faces of the work, as these can be drilled from the opposite side of the work, the jig then resting on the feet *B*. Should it, however, be necessary to drill one hole at an angle, and other holes perpendicular to the face of the work from the same side, an arrangement as shown in Fig. 95 would be used. The jig here is made in the same manner as the jig shown in Fig. 93, with the difference that the bushing *A* is placed at the required angle. It will be seen, however, that as the other holes drilled from the same side must be drilled perpendicular to the faces of the work, it would not be of advantage to plane the feet so that the hole *A* could be drilled in the manner previously shown in Fig. 94. Therefore the feet

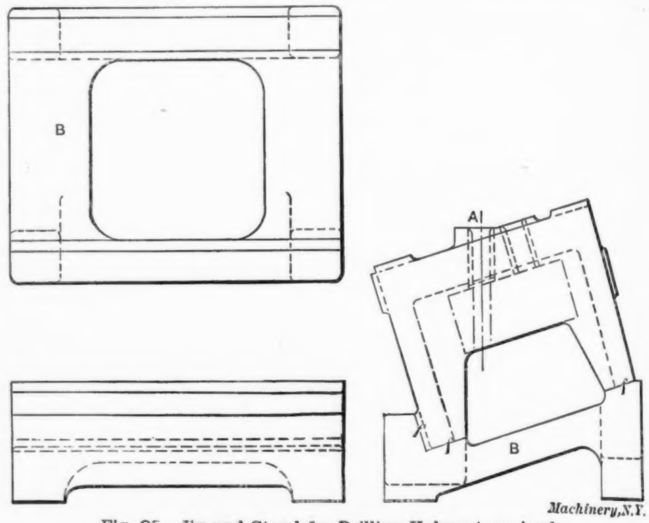


Fig. 95. Jig and Stand for Drilling Holes at an Angle.

are left to suit the perpendicular holes, and the separate base bracket *B*, Fig. 95, is used to hold the jig in the desired inclined position when the hole *A* is drilled.

Stand *B* in Fig. 95 is very suitable for this special work. It will be noticed that it is made up as light as possible, it being cored at the center, so as to remove superfluous metal. These stands are sometimes provided with a clamping device for holding the jig to the stand. Special stands are not only used for drilling holes at angles with the remaining holes to be drilled, but sometimes special stands are made to suit

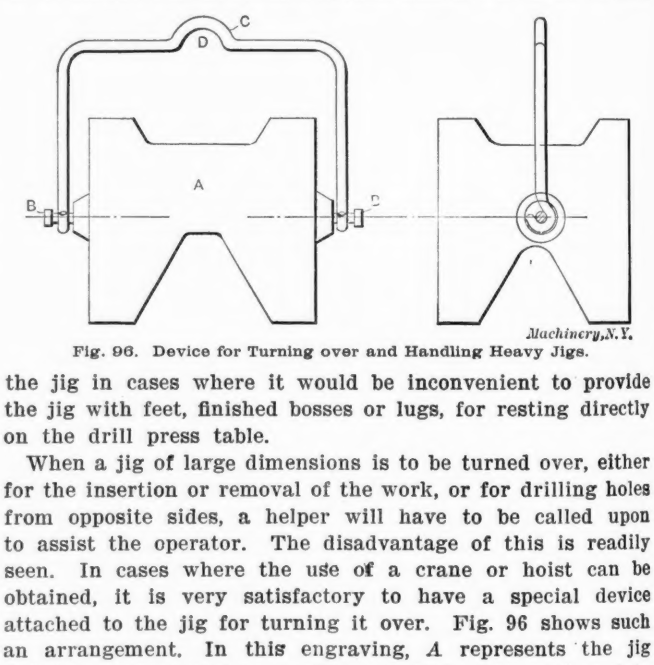


Fig. 96. Device for Turning over and Handling Heavy Jigs.

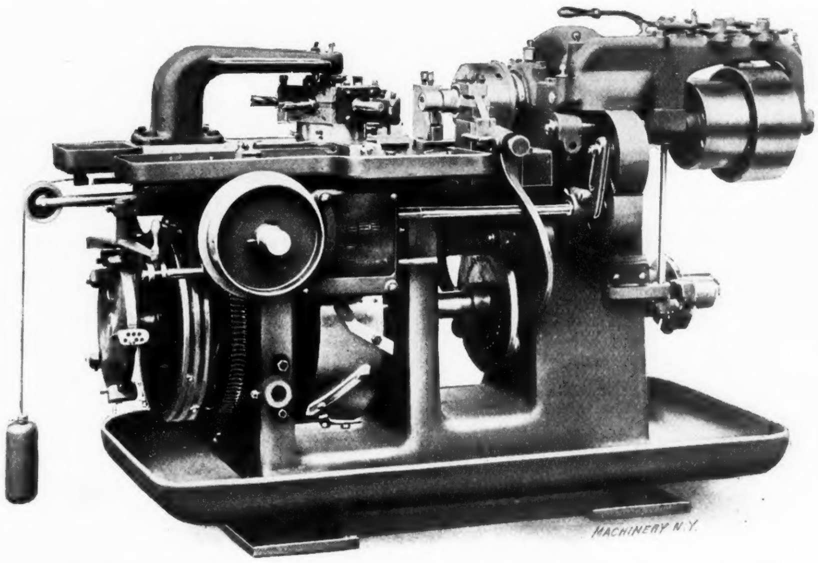
the jig in cases where it would be inconvenient to provide the jig with feet, finished bosses or lugs, for resting directly on the drill press table.

When a jig of large dimensions is to be turned over, either for the insertion or removal of the work, or for drilling holes from opposite sides, a helper will have to be called upon to assist the operator. The disadvantage of this is readily seen. In cases where the use of a crane or hoist can be obtained, it is very satisfactory to have a special device attached to the jig for turning it over. Fig. 96 shows such an arrangement. In this engraving, *A* represents the jig which is to be turned over. The two studs *B* are driven into the jig in convenient places, as near as possible in line with a gravity axis. These studs then rest in the yoke *C*, which is lifted by the crane hook placed at *D*. The jig, when lifted off the table, can then easily be swung around. The yoke is made simply out of round machine steel.

Comparing what has been said above with the outline of the development of open jigs in the September issue of MACHINERY, it will be seen that the principles involved are exactly the same, and that the development of jigs for various purposes is simply the application of these principles, with an appropriate amount of common sense, to the work in hand. The previous statements may be considered the A, B, C of jig making, and contain, of necessity, only the main principles on which the jig design is based.

HERBERT AUTOMATIC TURRET LATHE WITH SELF-SELECTING FEEDS.

On page 7 of the engineering edition of the September issue of MACHINERY was described, among other machine tools exhibited at the Franco-British Exhibition, an automatic turret lathe built by Alfred Herbert, Ltd., of Coventry, England. As described, the machine is intended for working on individual castings or forgings, or on blanks previously cut off. The work is chucked by hand, but all the operations performed on it are automatic, including the stopping of the machine at the completion of its cycle of operations. The head is gear-driven, and is provided with two sets of tight and loose pulleys, giving two speeds forward, or a forward and reverse motion, either of which may be shifted automatically, according to the requirements of the work. The machine in its general construction closely resembles the automatic screw machine built by the same firm, the modifications being, in general, only such as are required to fit it for finishing separate pieces as described, instead of making them complete from the bar.



An Automatic Turret Lathe for Castings, Forgings, and Cut Stock, in which Feeds may be varied for any Operation without Changing the Cams.

One of the most interesting features of the machine was not specifically mentioned in the description. This is the self-selecting feed mechanism, by means of which the rate of feed of the various tools in the turret may be varied independently of each other without changing the cams. The mechanism for this is most plainly seen in the rear view of the machine, shown herewith. In principle, the mechanism of the machine itself is identical with that of the original Spencer automatic screw machine. The feeding and controlling movements, such as the moving of the turret and cross-slides, the feeding of the stock, opening and closing of the chuck, reversing of the spindle, etc., are effected by cams and dogs carried on a long cam shaft, extending the length of the machine, beneath the bed. This is shown in the engraving. As in the original Spencer machine, this cam shaft may be given a rapid movement for the feeding and idle motions of the mechanism (such as returning the turret slide, etc.,) or a slow movement for feeding the cutting tools, the change from one to the other being regulated automatically by dogs. The improvement consists in furnishing a number of rates of feed for the slow movement, making it possible to change the feed for any tool without changing the cams, as was formerly necessary. On this machine, in fact, the turret feed cams (which are mounted on the large drum seen directly beneath the turret) are all of the same shape, the feed mechanism being depended on entirely for the change in feed.

The self-selective arrangement is controlled by a disk keyed to the cam shaft at its extreme outer, or left-hand end, as seen in the engraving. This disk carries a series of dogs, as shown, each of which is provided with 7 holes, in any one of which a pin may be placed. As the cam shaft revolves, this pin, just before the beginning of a new operation, enters the V formed by the two projecting wings of the horizontal lever shown above the disk, thus shifting it to a position corresponding to the position of the pin in the dog. The long end of this lever (provided with a handle, as shown,) carries a roller confined between collars on the splined worm-shaft which gives the slow movement to the cam driving mechanism. This splined shaft, which is thus adjusted from one position to another as occasion requires, is driven by a cone of 7 gears in the gear-box at the back of the machine. This gear-box is shown in the engraving with the regular cover removed, and replaced with one having a glass window to show the mechanism. The shifting of the shaft by the pins and dogs shifts the position of the key in the cone of gears, thus connecting the proper one with the feed mechanism and giving the desired feed to the cutting tool.

It will be noticed that the shaft by which the cone of feed gears is driven, is connected by change gearing with the spindle driving shaft. This arrangement gives a certain definite feed in turns per inch or thickness of chip, for each one of the 7 sets of gears in the feed-box, no matter what changes may be made in the spindle speed. Provision is also made in the connecting mechanism for giving a forward movement to the feed whether the spindle is running forward or backward. The feeding movement is thus properly controlled at all times. The use of change gears permits raising or lowering the whole range of feeds to suit any material the machine may be required to work on. The fast movements of the cam-shaft are derived from the pulley shown just to the left of the feed-box, which runs at constant speed so that these movements always take place in the quickest practicable time, without reference to the rate of rotation of the spindle and the consequent rapidity of the feeding movement.

While the machine here shown is intended primarily, as described, for working on castings and stock held in the chuck, there would seem to be no reason why the same idea could not be applied in a modified form to the automatic screw machine working on bar stock, thus materially increasing its usefulness. It would probably be necessary in such a case to have the threading cam of steeper pitch than the others, and it might be necessary to make it adjustable. Except for this, the arrangement would seem to be easily applied in the form here shown. The greatest usefulness of the device would appear to be in the opportunity it affords to change the feed for a given tool without altering that of any of the others. It would also appear to simplify the matter of setting up, to a considerable degree.

* * *

Isinglass is a term commonly confused with mica, although it is a totally different substance. Mica is a silicate mineral mined from the earth, while isinglass is an animal product made from the air-bladders of certain fishes. The best isinglass, which is used in superior belt cements, is made from the air-bladders of the Russian sturgeon caught in the Baltic Sea. This fish is the same as the sturgeon caught in American waters, but some peculiarity of the water or food in the Baltic makes a great difference in the quality of the air-bladder. The bladders taken from the American sturgeon are thin and of poor quality, being valued at about $1.50 per pound wholesale, while those taken from the Russian sturgeon are three or four times as thick and of far better quality, being valued at about $3.50 per pound. The difference is important to manufacturers and machine shop proprietors, as belt cement made with the best isinglass as its basis is stronger than leather. A belt properly joined with the best cement will break at some other point rather than at the cemented joint.

TOOLS FOR INCREASING PRODUCTION IN BLACKSMITH SHOPS.*

JAMES CRAN.†

The blacksmith has more difficulties to contend with in doing his work than any other class of mechanics. As a rule, he is heavily handicapped in not being provided with tools and appliances enabling him to do his work quickly and economically. To a certain extent he may be compared with the pattern-maker; he has to start his work, in the first place, with nothing to guide him except a blue-print or a sketch, often one-quarter or one-eighth size. This is all that is required, if the work is plain and of regular shape; but if it happens to be bent, curved, or in the least complicated, it must be laid out full size, and a templet made before the

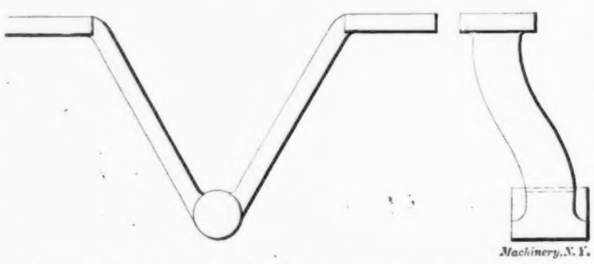


Fig. 1. Example of Forging Work which can be facilitated by using a Surface Plate.

actual work can be commenced. As compared with this, the machinist, and the majority of other mechanics, have their work shaped or partly shaped before it is turned over to them, which makes it comparatively easy. The pattern-maker can do most of his work at the bench; he can turn it around, and place it in any position to suit his convenience; he can stop at any time, and think over what his next move should be; he can cut, carve, glue, and build up, handling the work with his bare hands from the time he starts until it is completed. The blacksmith, however, is confined to the anvil or the steam hammer; his material must be heated before it can be worked to shape, and he must therefore handle it with tongs and lift and turn it with a crane if it is of large size; he has to make his plans and know exactly what his next move is to be while the material is heating, so that he will be able to do the greatest amount of work while the heat

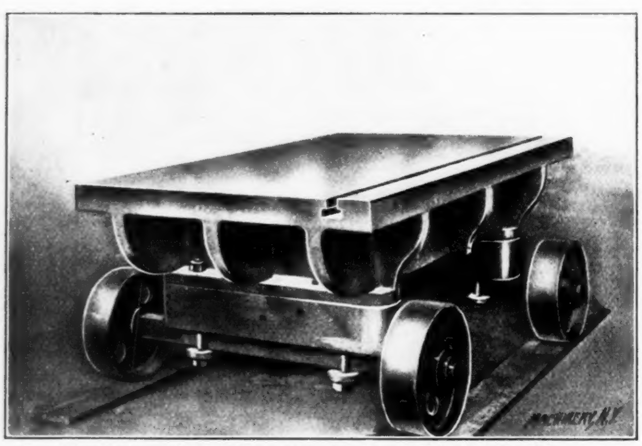


Fig. 2. Portable Surface Plate for Use in Blacksmith Shop.

lasts. Unlike other mechanics he cannot, as a rule, cut his work to shape, but draws, upsets, and bends it until it is ready for the machine shop.

To enable the blacksmith to do his work with convenience and accuracy, it would be well to supply him with some of the appliances that save time and reduce cost. In most blacksmith shops, forgings of odd and irregular shapes are, at times, made. Let us take the piece in Fig. 1, for example, which, while not complicated, would be a difficult piece to make with any degree of accuracy without a surface plate for trying the offset and the alignment of the different points. The surface plate shown in the half-tone, Fig. 2, is of a style best suited for machine blacksmithing. It was designed by a practical blacksmith and constructed so that it would meet, as far as possible, the requirements of the blacksmith shop. Being mounted on wheels, it can be moved around the shop to the place where it will be most convenient for the workman using it. The face is graduated in inches, which allows pieces being placed parallel with the plate and measured. Offsets and curves can also be gaged more accurately than would be possible if working from chalk lines. A T-slot, about four inches from one side, running the entire length, can be used for holding formers or similar tools to the surface of the plate. By using a square and a surface gage, the most complicated forgings can be made so nearly correct that there should be no trouble in machining the work.

A small surface plate of the same style should be provided for each forge. This plate need not necessarily be larger than eighteen or twenty-four inches square, with the face from 1¼ to 1½-inch thick. The plate is reinforced by ribs similar to those shown in Fig. 2. The wheels can be omitted, and a bench used to support the plate. A shelf may be placed between the plate and the base to accommodate clamps, bolts, etc., that may be used to hold work in position.

Benches with vises, attached to the walls of blacksmith shops, are not to be commended. There being no one constantly employed at the bench to keep things in shape, it is liable to be used as a place for dumping "any old thing." This not only gives the bench an untidy appearance, but makes

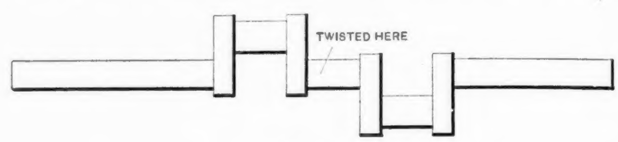


Fig.3

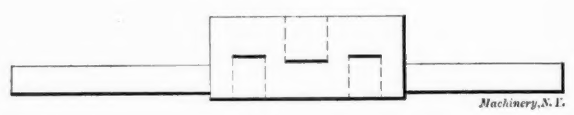


Fig.4

Figs. 3 and 4. Method employed for Forging Crank-shafts.

it necessary to clear up the space every time the bench is used. With a portable vise and bench this difficulty would be overcome. Every man using the bench would be expected to clear off every tool and piece of material before returning the bench to its place in the shop. Vises attached to a porttable cast iron bench mounted on wheels can be moved around the shop to the place where they will be most convenient, saving time that would be wasted if a number of pieces had to be taken to the vise separately for some operation, especially if it happened to be located in some distant corner of the shop.

An emery wheel is a very essential piece of machinery for the blacksmith shop, as it is necessary to grind chisels and other tools quite often. If they have to be taken to another department for grinding, it means the waste of considerable time both for the blacksmith and his helper. No matter which one of them goes to do the grinding, the other generally takes a rest until the absent one comes back. Almost any type of grinder would answer the purpose, but the style known as the wet grinder is the most suitable, especially if arranged to supply the water automatically; otherwise it is liable to be used as a forging machine, which is bad practice for the blacksmith and poor usage for the wheel.

For cutting up stock and trimming the ends of forgings, such as shafts, spindles, or similar work, a power hack-saw can be used to good advantage. It requires but little attention, so little, in fact, that the blacksmith or his helper could attend to it between the heats without in the least interfering with their work at the forge. It cuts off the ends of forgings neater than is possible by hand, and the time it saves means increased production without increasing cost. It can also be used to advantage in the process of forging various pieces. Take small crank-shafts for example, as

* For additional information on kindred subjects, see the following articles previously published in MACHINERY: The Steam Hammer and Its Use, October, 1908; Tools for the Blacksmith Shop, September, 1908; System for the Blacksmith Shop, August, 1908.

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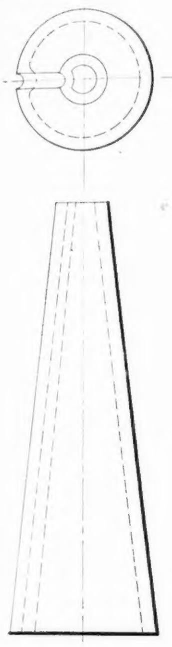
shown in Fig. 3, which are usually forged with the crank or throw solid. The stock between the webs must be removed either by drilling small holes around it, or by using a slotting machine. By using a hack-saw, the crank can be put in shape for the lathe before it leaves the blacksmith shop. The stock intended for a crank should be wide enough for



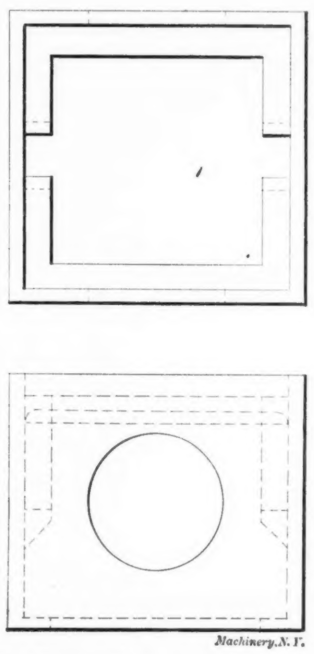
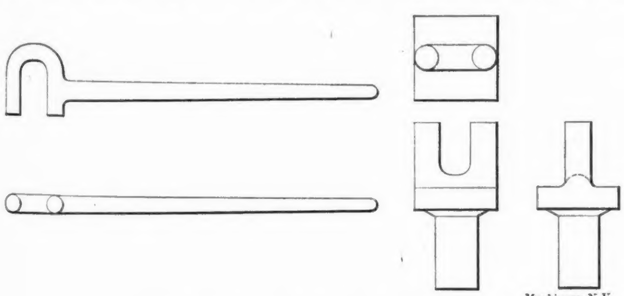


Fig. 5. Taper Cone for Forging Rings, Collars, etc. Fig. 6. Base for Swage Blocks.

the throw on one side, the journals should then be drawn out and rounded, after which the piece between them should be laid out as shown in Fig. 4, care being taken to keep the distance between all the webs short enough to allow for drawing in rounding the bearings. A small hole should be drilled at each corner for the hack-saw to run into. When the hack-saw has cut along the dotted lines, the crank can be heated, and the pieces removed with a chisel applied where solid lines are shown in Fig. 4. When the bearings are rounded, the crank-shaft can be heated and twisted so as to bring the throws on opposite sides of the forging. Any number of throws can be made in the same manner and could be set at any angle by using a surface plate.

The majority of up-to-date concerns manufacturing heavy machinery have a number of portable motor driven machines which can be taken to the work when it is inconvenient to take the work to the machine. These machines are usually credited with being time and labor savers, and, as a rule, cost



Figs. 7 and 8. Tools for Bending Work.

less to manipulate on certain kinds of work than would machinery installed in a permanent position. Portable motor-driven appliances for the blacksmith do not, however, seem to have received much thought or attention up to the present time. Yet, there is no mechanic who could use portable appliances to better advantage than the blacksmith. A portable forge with a motor-driven blower attached could, perhaps, be used for a greater number of purposes than any other portable appliances. Long pieces could be welded in the majority of cases with less trouble than with an ordinary forge. Such a forge could be used for heating braces or similar work in fitting them to castings or tanks. In short, any kind of work that is done at the ordinary forge could be done at any time or place where the appliance could be connected with electric power. If mounted on small wheels or casters and fitted with a handle of the style used for small trucks, this forge could be moved around anywhere with very little trouble, and work of larger dimensions could be handled than is possible with the portable hand forge commonly used for work done outside the blacksmith shop.

Some shops are provided with taper cones or mandrels for truing up rings or similar work. A set of taper cones, of which there are several styles on the market, is inexpensive, and well worth a place in the blacksmith shop equipment. The kind that is most convenient to use and gives the most satisfaction is shown in Fig. 5. This style of cone has a U-shaped groove its entire length, which permits tongs to be used to remove or place work upon it more conveniently than with the unslotted kind.

Swage blocks take the place of a large number of individual tools, particularly bottom swages and heading tools. There probably is a larger variety of shapes and sizes of swage blocks than of any other blacksmith tool on the market. The style that comes nearest meeting the requirements of machine blacksmithing is the square pattern with circular, hexagon, and V-shaped impressions around the outside edges, and square and round holes of different sizes in the center; one side of these holes should be countersunk. If mounted on a cast iron base or block, such as shown in Fig. 6, the swage block can be conveniently used either for swaging or heading forgings, by standing it on its edge in the recess in the center of the block, or laying it flat in the flanged section at the top.

In bending work to curves or sweeps, dogs of the style shown in Figs. 7 and 8 will answer the purpose better than

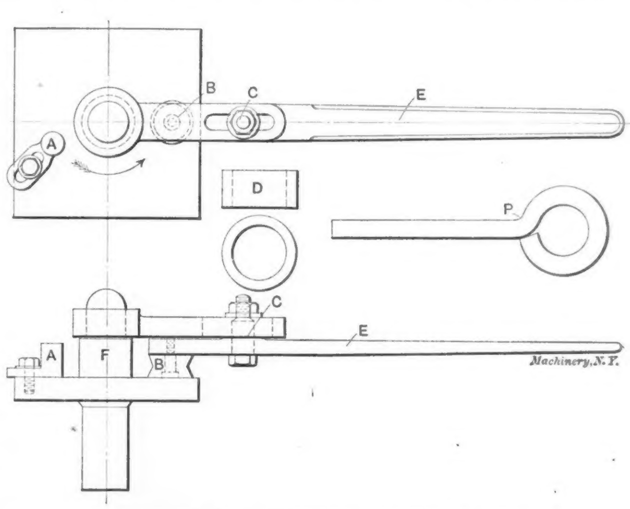


Fig. 9. Tool for Forging Open Eyebolts or Hooks

any other tool. They can be used either on hot or cold work. The tool in Fig. 7 is intended to be used by hand in combination with that in Fig. 8, which latter should fit the square hole in the anvil. In making tools of this kind, it is important that the one to be used by hand be as shown, so that its bearing upon the work will be in line with the end of the handle; this prevents twisting of flat work or slipping on round work.

A tool for bending open eye-bolts or hooks is shown in Fig. 9. The shank of this tool is intended to fit the anvil. The part *A* is an adjustable guide for forming the first bend marked *P* on the eye-bolt shown. At *B* is shown a grooved roller which bends the eye to shape when turning the handle *E* from the left to the right as shown by the arrow. At *C* the lever is jointed, which allows adjustment for different sizes of material, and permits the roller to follow the shape of forming pin *F*, should its shape be other than round. The loose bushing shown at *D* is used to increase the size of forming pin *F* for making larger hooks or eyes. The bushings may be of any shape, but if other than round, they should be held in position by dowel pins. Tools of this kind should be fitted with an adjustable gage, so that the right amount of stock will be used for each piece. Hooks or eyes made on a tool of this type will not only be neater and more uni-

form in shape, but can be made in one-quarter of the time required if made by hand.

An appliance that would save time, trouble, and a large amount of unprintable language, is a small crane or hoist for each forge, to be used only for work at the anvil. When too long or heavy for one man to handle, it is often necessary for the blacksmith to get another man to help him to handle heavy work. If trestles or "horses" are used, they must be moved or adjusted in height every time the piece is turned or moved, which often takes as much time as is used in doing the work itself. A small crane made of structural shape steel or steam pipe, properly trussed and braced, and fitted with a 1,000-pound chain hoist and snatch block, would overcome most of the difficulties. It could be easily adjusted to any height or position, would not come in the blacksmith's way, and would always be found in its place when wanted.

No blacksmith shop equipment is complete without platform scales for checking the weight of forgings and weighing stock before being used. It takes less time to weigh any kind of iron or steel than it does to figure out its cubic capacity and weight.

Machinery and tools help the blacksmith as much as any other mechanic; they make it possible for him to do more and better work, increase production and reduce cost, and thereby add to the efficiency of the blacksmith shop.

* * *

The use of denatured alcohol gas has not yet grown to the proportions confidently expected by the promoters of the industry. It was thought that when the United States government tax of $1.10 per gallon was removed, the use of denatured alcohol would soon rival that of gasoline for power purposes. The drawback to the extensive use of denatured alcohol is that so far it has not been feasible to manufacture it from vegetable products at a price that would successfully compete with gasoline. There is considerable interest now in the process of making alcohol from natural gas. Representatives of the Internal Revenue Department of the United States Government have visited Europe to study newly developed methods of manufacture of methylated or denatured alcohol from natural gas and crude petroleum. The Germans, with their characteristic enterprise for chemical research, have discovered a process which has unusual commercial possibilities. A company has been organized in the United States to promote the industry, which is being backed by Mr. Carl von Hartzfelt, Wheeling, W. Va., who also has discovered or invented a process. It is claimed that by the American process, 5,000 feet of natural gas will produce 50 gallons of alcohol, and that the cost of alcohol will be greatly reduced. Natural gas is sold to consumers in the gas fields of some localities as low as 10 cents per thousand cubic feet. At this rate the cost of gas per gallon of alcohol produced would be about one cent. Natural gas contains about 94 per cent methane, and the percentage of alcohol which may be obtained varies with the percentage of methane contained. The process is essentially as follows: The natural gas is subjected to heat in the presence of oxygen and steam which prevents complete combustion, inasmuch as the temperature is kept below the decomposing point of alcohol and destructive distillation or oxidation of the gas is induced. The action takes place in an electrically-heated German silver coil of closely woven fine wire gauze enclosed in a porcelain retainer or enamel retort. The product is a fluid containing alcohol, benzol, nitric acid and prussic acid.

* * *

It is interesting to note the low temperature obtained by Professor Onnes, when liquefying helium, to which reference was made in the September issue of MACHINERY. During his experiments, he kept helium at a temperature of 4.5 degrees K. for two hours, and finally evaporated the liquid under a pressure of about one centimeter of mercury, when the temperature is estimated to have been not far from 3 degrees K. The expression 3 degrees K. means 3 degrees centigrade above absolute zero, the expression being derived from the name of the late Lord Kelvin, who first defined the zero of the absolute temperature scale.

SYMBOLS IN MATHEMATICAL AND ENGINEERING FORMULAS.

The subject of making certain symbols, representing mathematical quantities in scientific publications, the same in all languages, has been considered for some time by the International Electrotechnical Commission, which has committees in different countries. These committees deal more especially with symbols for electrical quantities, but the system might, with advantage, be extended to embrace all important quantities in the field of engineering. The difficulties met with, are, in the first place, the difficulty of persuading a number of writers and publishers, who have become accustomed to a certain symbol for a certain quantity, to change it in favor of another, and, in the second place, that there are not enough letters in the alphabet at our disposal to give an absolutely distinct symbol to each quantity, without resorting to a combination of more than one letter to form a single symbol. There is also another objection to using letters to represent quantities in a system of universal notation, because, unless initial letters are used, there is no connection in the mind of the reader between the letter and the quantity, and the symbol is difficult to remember. We cannot always use initials, because the initial letters differ in different languages. For instance, in England R commonly stands for resistance, while in Germany the letter W is used, representing *Widerstand*; besides, the same initial occurs in a great number of different quantities. For instance, R might stand for resistance, reluctance, radius, etc.

The only way of avoiding both difficulties would be to use a number of new symbols, for which type could be made like ordinary letters, and which would represent distinct quantities in engineering formulas. In choosing a symbol a simple picture would be selected that would remind one of the quantity in question. For instance, might represent temperature. If we were told that this simple outline of a thermometer represents temperature, there would be no difficulty in remembering it. Similarly, / might represent force, and various other symbols might be derived from it. For instance, ϟ, electro-motive force (conventional representation of lightning); and ∩ magneto-motive force. Any formula expressed in symbols which have a definite meaning, would be completely self-contained, and would be an exact statement of a mathematical or physical fact. Perhaps some slight addition to the symbol, or even to the whole formula, could be used to indicate that the standard system of units is employed, and without such an addition the symbol would have a general meaning. For instance, might equal temperature, while might indicate the degrees Centigrade above absolute zero. The name of the type might be the name of the physical units which it represents. For instance, ϟ might be read "volts."

The British Electrotechnical Commission invites writers and others who have some definite views as to the best method of devising an international system of symbols, to communicate with its secretary, Mr. Miles Walker, The Cottage, Leicester Road, Hale, Altrincham, England, if they wish to assist in solving some of the many difficulties which arise in connection with this matter.

The question of an adequate system of notation is really one of great importance to engineers. Everyone who has to deal with handbooks, and with formulas found in various text-books, is familiar with the annoyance of finding a formula, and having difficulty in locating the exact meaning of the various terms used to express the quantities involved. A universal system of notation, when once adopted by the engineering profession, would make it possible to make more concise and precise statements in shorter space, and at the same time misunderstandings would be largely avoided. It is to be hoped that the commission referred to above will be successful in adopting some standards of notation for the electrical quantities, and that engineering societies in various countries will also take up the matter, and, acting in unison, agree upon an international system of notation which would be adopted as the standard, thereby eliminating the present confusion.

A MODERN STEEL-HARDENING PLANT.

The illustrations, Figs. 1 and 2, show two views of a hardening plant installed by Wheelock, Lovejoy & Co. (selling agents for Firth Sterling Steel Co., McKeesport, Pa.) in the basement of their New York store at 23 Cliff St. The equipment is interesting in that it represents the latest development of gas furnace hardening and tempering baths. Fig. 1 shows a general view of the plant looking toward the street, while Fig. 2 is a view taken from the street end. The furnace in the rear, with a hood similar to the one in the foreground of Fig. 1, is for heating a chloride of barium bath, this being very successfully used for hardening "Blue Chip" steel, and the following notes relate to the practice:

The business of the company is selling tool steel, but in order to secure the best results and common satisfaction, it was found desirable to educate users to a knowledge of modern methods of heating and hardening high-speed steel. The plant was installed for this purpose and is used chiefly for hardening and tempering samples of work submitted by customers, thus demonstrating the capability of the steel for a multitude of purposes, and the best methods of treatment. An inspection of the plant gives proof of the great advance made in recent years in methods of heating, hardening and tempering. Nothing now need be left to chance or guesswork; every step can be made with absolute certainty as to the results. Thus have scientific methods and instruments practically eliminated the mystery and uncertainty attending the manipulations of the old time tool-smith who, working in his grimy dark corner, was one of the last members of ancient crafts to yield to the march of improvement.

Fig. 1. Hardening Plant, Wheelock, Lovejoy & Co., looking toward Street.

The tools to be hardened are first pre-heated, using a small American gas furnace shown next to the chloride of barium furnace. The pre-heating saves time in the barium bath, and is absolutely necessary to avoid checking or cracking the tools, as will be conceded when it is known that the temperature of the barium bath is kept at between 2,100 and 2,200 degrees F. After the tools are pre-heated, they are immersed in the barium bath, being suspended by an iron wire, or, in the case of small parts, in sheet nickel baskets. The reason for using sheet nickel for the baskets is that chloride of barium has a slight dissolving effect on iron and the exposure of a large area of sheet iron in the bath would eventually destroy the baskets. Nickel is not affected, nor is the thin iron wire used to suspend ordinary tools, to a perceptible extent.

The temperature of the barium bath is regulated by a Bristol thermo-electric pyrometer. This instrument, shown at the left in Fig. 3, is similar to a Weston ammeter or voltmeter, and the fire end is a thermo-electric couple. The heat of the bath effects the thermo-electric couple and generates a current that deflects the indicator of the indicating instrument to correspond with the temperature. For convenience of operation, the indicating instrument is provided with a double hand, one hand, *A*, being controlled by the temperature of the bath, while the other, *B*, is a marker set by the operator to indicate the temperature which he desires to carry. This marker is made with a disk at the end that covers a hole in the indicating hand when the two coincide, as they do when the temperature has reached the predetermined point. Thus, an operator whose eyes are dazzled by the heat of the bath does not have to painfully study the graduations to see whether the pointer has reached the correct position, but by glancing at the instrument he can readily determine when the indicator is directly beneath the marker referred to.

The immersion of a piece pre-heated to a dull red immediately causes the indicator to drop, the temperature of the

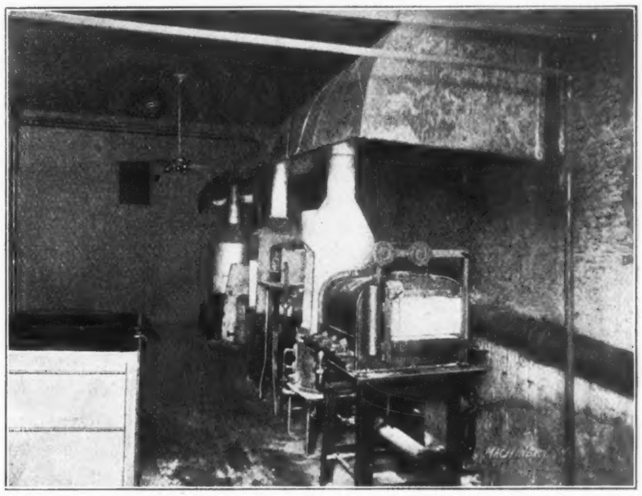


Fig. 2. View of Hardening Plant, taken from Street End, shown in Fig. 1.

bath falling perhaps 30, 40 or even 50 degrees. The fall in temperature is due to absorption of heat by the piece, being the same as the refrigerating effect of a lump of ice thrown into a pot of boiling water, and several minutes may be required to raise the temperature of a large piece to the temperature that is required. For hardening "Blue Chip" steel, a temperature of 2,120 to 2,140 degrees F. has been found most suitable. After this temperature is attained, the part is allowed to soak for a few moments, then is lifted out and dipped into the cooling bath shown at the right, Fig. 1, and left in Fig. 2, which consists of cotton-seed oil agitated by compressed air admitted at the bottom. The cotton-seed oil is contained in a large iron barrel surrounded by water in a wooden tub. The part hardened is allowed to remain in the bath until it is quite cold. In practice, the operator hardens a batch and then removes the pieces by means of a wire basket hanging immersed in the oil. It is recommended that milling cutters, end mills, slitting saws, etc., made of

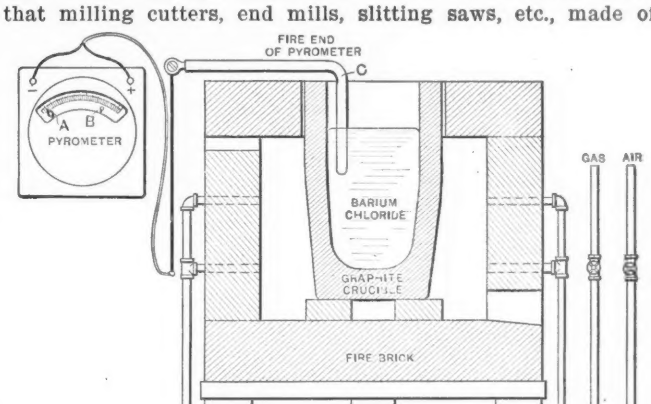


Fig 3. Vertical Cross-section of Chloride of Barium Furnace.

"Blue Chip" steel, be used, in general, without drawing the temper. They will have the requisite hardness and toughness to stand up to the majority of work. However, an oil bath heated by gas and regulated by a thermometer is provided for tempering such tools as require it.

Chloride of barium is a white transparent salt ($BaCl_2OH_2$) which melts at a temperature of about 1,700 degrees, the

water of crystallization being driven off at a much lower heat. The salt volatilizes at an extremely high temperature, the loss at the temperature required for heating high-speed steel being negligible. The waste because of volatilization is, say, two pounds from a mass of barium weighing 75 pounds when held at a temperature between 2,000 and 2,300 degrees for five hours. This property of the chloride of barium bath of standing high temperatures without rapid volatilization is joined with others equally important. The piece heated is protected from the atmosphere during the heating period by the bath, of course, but the protective influence extends still further. A thin coating of barium clings to the piece when it is lifted out for immersion in the cooling bath, thus preventing oxidation. The effect of the barium on the steel seems to be limited to a slight mottling that quickly disappears under the action of cleaning and buffing wheels. The coating of barium remaining when dipped, prevents the coating of burned oil so troublesome to remove, so that on the whole the process probably produces the cleanest work of any bath known.

Wheelock, Lovejoy & Co. have improved the furnace and crucible used for the chloride of barium bath. The common form of furnace and crucible in use employs a comparatively shallow crucible, which necessitates making a joint between the top of the crucible and the fire-brick cover. This gives trouble by loosening and permitting the hot gases to escape around the edge of the crucible. The improved construction illustrated in Fig. 3 utilizes a deeper crucible, the top of which comes flush with the fire-brick cover and simplifies the construction. The deep crucible also gives a greater volume of chloride of barium, consequently the refrigerating effect of the pre-heated steel parts when immersed in the bath is not so great. This illustration also shows the fire end, *C*, of the pyrometer immersed in the bath. It has been found advisable to employ crucibles made for steel melting, the ordinary graphite crucible used for brass melting giving trouble by flaking off into the barium.

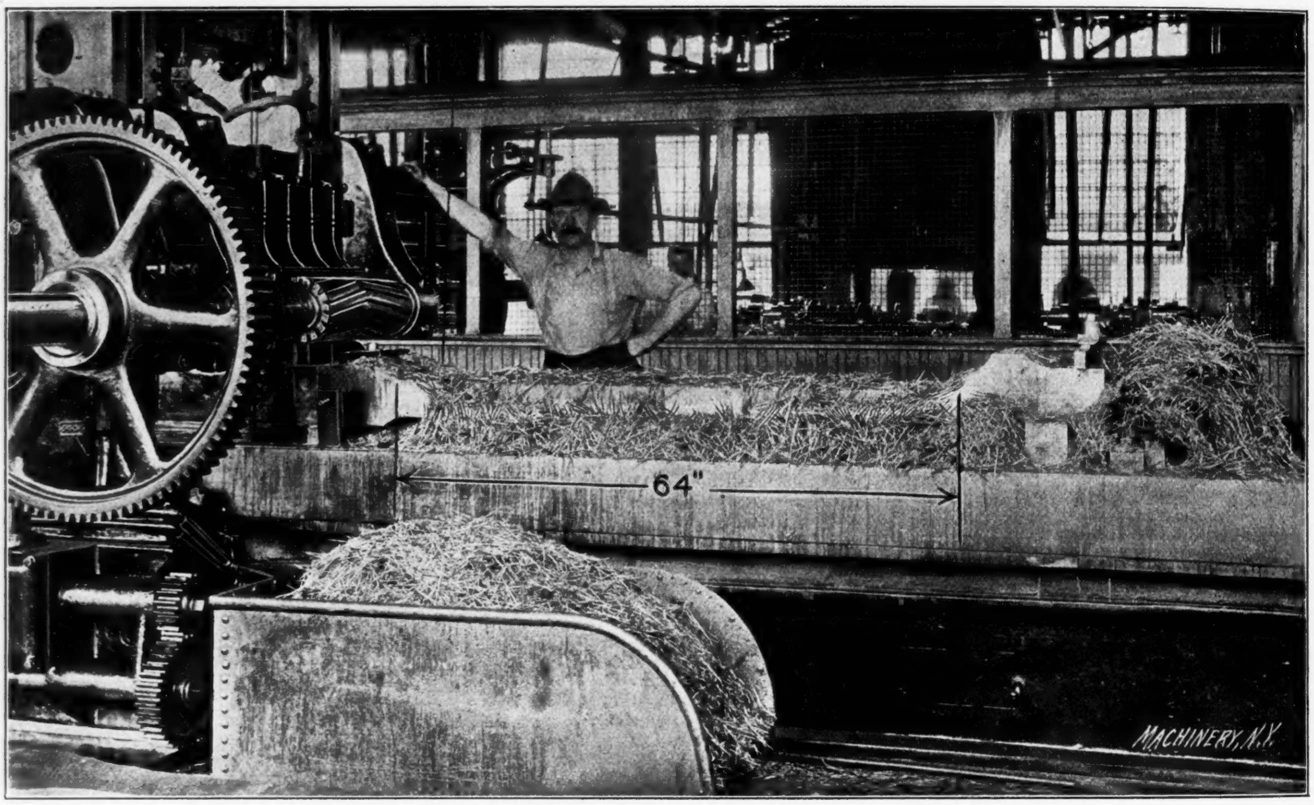
The equipment of the plant includes an air compressor and exhauster, the former being required for the air blast in the furnaces and for agitating the oil bath, while the exhauster connected with the smoke pipes and hood, draws off the hot air and gases, thus keeping the working conditions fairly comfortable, even in the hottest weather. An efficient ventilating system is a prime requirement, inasmuch as the fumes of the barium are somewhat noxious and besides would have a serious rusting effect on the steel stock if permitted to pervade the basement where it is stored. The chloride of barium process is used by the Boston and Chicago selling agents of the Firth-Sterling Steel Co., also.

* * *

HIGH-SPEED MILLING ON LOCOMOTIVE PARALLEL RODS.

The illustration does not show a hay-cutter nor a tooth-pick machine; it is a Bement-Miles milling machine, milling four heavy locomotive parallel rods, in a well-known locomotive works. These parallel rods, as well as many other locomotive forgings, are only roughly forged, it having been demonstrated long ago that it is cheaper to rough forge in the blacksmith shop to approximate shape and dimensions, leaving plenty of stock to finish up on the machines. The labor and fuel in the blacksmith shop are much more expensive than the labor and machine service in a well-equipped modern machine shop. It is on forgings of this and heavier types that high-speed steel has made its greatest records.

The rate of traverse on the middle portion of the rods was 5 inches per minute, 13 minutes being required to mill the straight part, which is 64 inches long between the end bosses. The bosses or end sections of the rod, which are enlarged for the reception of the crank-pin, are about 17 inches long and the profile is a combination of curves and straight surfaces. These sections were milled in 28 minutes each, the additional time per lineal inch of traverse being due, of course, to the greater amount of material removed and the repeated settings of the cutters required for the forming operations.



An Example of High-speed Milling on Locomotive Parallel Rods.

The milling cutter is composed of two parts having straight teeth set at an angle with the axis, the teeth being high-speed steel. The parallel rods shown in the illustration are 54 points carbon. The quantity of chips shown on the table gives a hint of the amount of metal removed from the top surface of the rods. Repeated tests made on heavy milling machines of the type shown, indicate that from 1½ to 2¼ horse-power is required for one cubic inch of steel removed per minute.

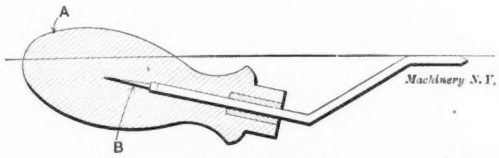
* * *

An ill-natured reprimand, an unexplained promotion, a summary dismissal—all these put emery powder in the grease-cups.—*The Silent Partner.*

ITEMS OF MECHANICAL INTEREST.

A HANDY SCREW-DRIVER.

A contributor to *Wood Craft* calls attention to a simple little tool which is handier than the ordinary screw-driver, particularly for putting in small long screws. It consists of a handle *A* in which is drilled a hole, so that a wire, say 3 inches long, will revolve in it without much friction. Into the bottom of the hole is driven a small brad *B* which is used as a bearing for the end of the rod constituting the screw-driver proper.

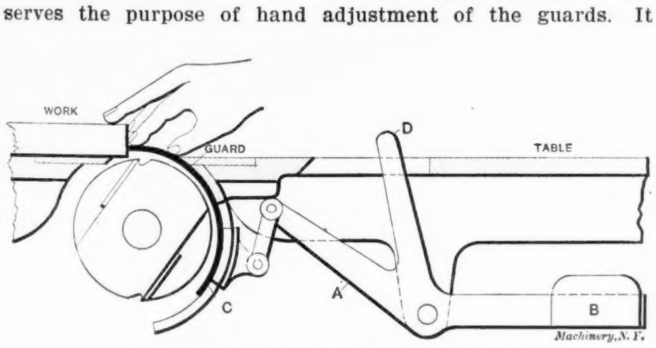


Screw-driver for Rapid Action.

The outer end, of course, is flattened to suitable dimensions. It will be seen that the tool constitutes a very neat little screw-driver, which will sink small screws very rapidly by simply revolving the handle like a crank, in the proper direction. A number of wires with different sized ends can be kept on hand, and interchanged as conditions require.

SAFETY DEVICE FOR BUZZ-PLANERS.

An interesting and effective safety device for buzz-planers has been patented by Mr. Lundberg, of Wernamo Mekaniska Verkstad, Wernamo, Sweden. The general arrangement of this device is illustrated in the accompanying line engraving. The principle of the device is that plates or guards *C*, of a semi-circular form, are held up against the end of the work when it passes over the cutter, by a weight *B* on the end of lever *A*, suitable linkage connections being provided between the lever and the guard. A number of these guard plates are placed side by side across the full width of the planer. It will be noticed that one arm *D* of lever *A* extends up through the table of the machine when the guard is in action, but when the work entirely covers the opening over the cutter, having pushed the guard clear back, this end of the lever is turned below the surface of the table. The handle of the lever serves the purpose of hand adjustment of the guards. It will be noticed that the cutter is covered at all times, either by the work, the work and guard in combination, or by the guard alone, so that at no time is any part of the cutter exposed. The weight *B* on the end of the lever makes the action automatic.



A Swedish Safety Appliance for Buzz-planers.

This guard fills also some of the very most important requirements of safety devices for machines of any type. In the first place, it is unobstructive to the working of the machine, and for that reason there is no incentive for the workman to remove it. Not only is there no incentive for the workman to remove it, but it is also very difficult to remove, and practically impossible to keep inoperative while in place. As the guard is made in sections, each of which covers a part of the full width of the table, it covers the cutter not only in line with the work, but completely on each side of the work as well. The simplicity of this construction, the ease with which it can be temporarily withdrawn for the changing of cutters, and the way in which it prevents dust and chips from entering into and obstructing the working of its own mechanism, are all factors which indicate the thoroughness of design, and that all the requirements have been well taken care of.

A SLIDE RULE FOR TRIGONOMETRICAL PROBLEMS.

A slide rule which is specially graduated for convenience in solving trionometrical problems is illustrated in the accompanying half-tone engraving. It is the invention of Mr. M. J. Eichhorn, 5759 Aberdeen St., Chicago. As seen from the engraving, this slide rule is constructed in the same manner as an ordinary calculating rule, but it is graduated in an entirely different manner, so as to be especially adapted for the solution of the formula

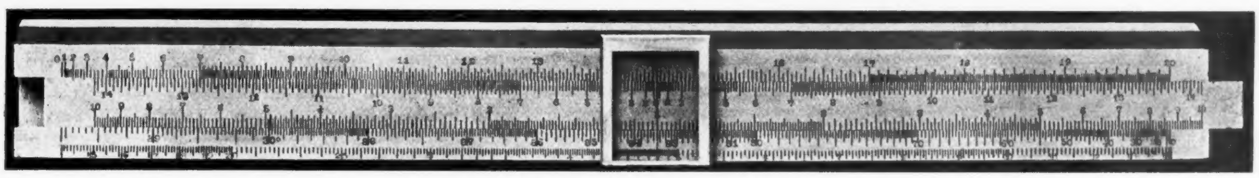
$$C^2 = A^2 + B^2 + 2AB \cos c$$

which is the well-known expression for the value of the third side in any triangle, when the two other sides and the angle between them are given. It is clear that this formula can be transformed so as to give an expression for practically the entire range of plane trigonometry, as either *A*, *B*, *C*, or *c* can be considered as the unknown quantity, and the equation can be solved for the same, thus giving a solution for any of the four basic classes of trigonometrical problems. Of course, the main reason why the formula is not used ordinarily for the sides *A* and *B* when transformed for solving either of these, is because it becomes rather cumbersome, and is not adapted for direct use of logarithms, thereby involving a considerable amount of ordinary figuring. When triangles are to be solved, however, and an approximation of three or four figures is sufficient, such as may be obtained within the length of a slide rule, the formula above can be so transposed as to permit of an easy solution on a slide rule specially graduated for the purpose and as shown in the illustration. For this purpose, we substitute as follows in our equation:

$$X^2 = 2AB \cos c$$

and

$$C^2 = A^2 + B^2 - X^2$$



A Slide Rule for solving Trigonometrical Problems.

The latter formula gives an expression which permits of solution on the trigonometrical slide rule. The slide is set in relation to the scales on the main body of the rule so that the known values of *A*, *B*, and *X* are taken care of, and *C* can be read off directly on the rule.

To permit of solving so complicated a problem, the instrument is, of course, provided with a rather ingenious system of graduation, and it suggests the idea that special slide rules can be constructed for the solution of rather complicated formulas, which are used very frequently in certain classes of work. The relation that such slide rules would have to the ordinary slide rule would be the same as that of special machinery to more or less universal machines. The ordinary slide rule, like the universal machine, is adapted for a great number of different operations, but is not adapted to carry out any one of them with particular speed, while a special slide rule, like a special automatic machine, would be suited to one particular operation only, which, however, could be carried out accurately, easily and rapidly.

* * *

Some concerns are so busy getting new customers that they have no time to take care of their old ones. Somebody ought to call around and recite that old saying about the value of a bird in the hand.—*The Silent Partner.*

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SYSTEMATIC STUDY.

From time to time we receive letters from subscribers asking for advice in regard to the best methods of increasing their knowledge along mechanical lines. It would be difficult to give an absolute rule to be followed for self-education, or to say which subjects are of the greatest importance, and which should be studied in preference to others. It all depends upon the work in which the person asking for advice is engaged, or for which he intends to fit himself, and upon his own mental make-up. There is, however, one rule that can be given without qualification or limitation, to everyone, and that is, *study systematically*. Do not take a book and read one chapter, and then turn to another and study up a different question, unless the foundation on which you build is already of such proportions as to permit adding to the structure in this haphazard manner. Start with some good book on the fundamental principles of the work you are engaged in, or of the work for which you intend to fit yourself, and study systematically and earnestly. Do not jump certain parts, because they do not, at the time, directly interest you. Make it a point to have certain hours which you devote to study, and certain hours to recreation. If this general advice is followed, at the end of each year you will find that you have stored up a great amount of knowledge which you would not have been in possession of had you not followed a method in your study. After a while systematic study will become a habit, and then your mental capacity will increase, and your ability to grasp and understand will be so developed that study is no longer an effort, but largely becomes a diversion.

* * *

RELATION OF EMPLOYES TO TRADE SECRETS.

The question of trade secrets has of late attracted some attention, particularly on account of the recent petition for an injunction brought by a well-known manufacturing company against two of its former officials. Another litigation, which merits attention by both employers and employes, is that in which a recent decision has been rendered by a New Jersey court. The complaining company had been engaged in making a special alloy steel, and a person in the employ of the company had made a contract that he would not at any time, directly or indirectly, during the term of the agreement or afterwards, divulge to any person, firm or corporation, except to officers of the firm with which he was employed, any information of any nature, known to him or thereafter acquired by him during the term of the agreement, relating to or regarding any process of steel making, or molding or treating steel, that may have been, is, or might be, during the term of the agreement, used by the company. The court, however, ruled that a contract of this form cannot be enforced, as it not only forbids the defendant to disclose any secret of the complainant, but also any knowledge that he may have relating to steel making in general. The necessary results of the enforcement of the contract would be that the defendant must either work for the complainant or remain idle, and since the restraint is unlimited as to time and place, he might at the option of the complainant, after the expiration of the term of the contract, be without employment for the rest of his life at the only calling he knows. Such a restraint, the court said, savors of servitude, unrelieved by an obligation of support on the part of the master. Comment seems unnecessary. Any reasonable minded man, whether employer or employe, will grant that contracts of this kind are disgraceful to the party demanding them.

* * *

MECHANICAL FLIGHT.

The year 1908 will be remembered for the extraordinary progress made in mechanical flight. The present stage of development of the aeroplane by the Wright brothers, Farman, Delagrange, Curtiss, and others is such that we may truthfully say that the possibility of mechanical flight has been conclusively demonstrated. The step from the ignorance of centuries to the present knowledge of the laws of flight and the structural requirements of the flying machine doubtless is greater than for all future knowledge that will be acquired in the complete mastery of aviation. The conquest of the air is a matter of satisfaction for the machinist and machine designer. The Wright brothers' experiments which, doubtless, have been more thorough and comprehensive than those of anyone working on the problem of aeroplane navigation, were made with a skill and insight into mechanical principles derived from their experience as bicycle builders. The design of the extraordinarily light and powerful gasoline motors that develop a horse-power for each three pounds of dead weight, or even less, is in itself a great achievement, and is one that has contributed in no small degree to the success of the heavier-than-air machines. It is to the machine designer that we owe thanks for this wonderful motor construction.

The mechanic has had a greater part in the present triumph than the theorists who have attempted to formulate laws of flight by mathematical analysis and deduction. The experience of the Wright brothers shows that practically nothing was known of the action of the atmosphere on moving planes, especially when these moving planes were propelled by motors. Experiments with kites, while useful, have led to many wrong deductions. The tables of wind pressures per unit of area for various velocities appear to be all wrong when it comes to bodies standing at angles in the air. The unit wind pressures vary according to the size and shape of the wings. The Wright brothers say, in their article in the September *Century*, that the wind pressures on squares are different from those on rectangles, circles, triangles, or ellipses; arched surfaces differ from planes, etc. They found, "contrary to the teachings of the books, that the center of pressure on a curved surface travels backward when the surface was inclined, at small angles, more and more edgewise to the wind." A great many other confusing and contradictory facts were discovered in their experiments at Kitty Hawk, N. C., which demonstrated how little really was known about the mechanics of the atmosphere. It is gratifying, however, to learn that the theories advanced were of value to experimenters, although in many cases, wrong. The theories served at least as something to grasp at and thus in a degree did illumine the dark way of the youthful investigators. The problem of aerial navigation is tremendously complicated by many unknown factors, and it is no wonder that mathematical analysis and deduction were found at fault in many vital respects.

AN ABUSE OF PATENT RIGHTS.

Some time ago an infringement suit was brought by an Eastern company against another firm manufacturing a like product, in which the court had to decide the question: Can a manufacturer buy a patent, never make use of it, and still sue for infringement? The decision, as rendered by the Supreme Court of the United States, was to the effect that the owner of a patent, after having bought it, has an absolute property right in it whether he uses it or not, and has a right to withhold from the public the benefits derived from the invention. This decision, no doubt, conforms with our present patent laws, but it is safe to say that laws so enacted and interpreted do not carry out the original purpose of patent protection, which was simply to insure to the inventor the right of deriving full benefit from the invention, by exclusive privilege to use or manufacture for a certain number of years, and by no means included the right to prevent others from deriving a benefit from something which he did not care to use himself. The present patent law appears to operate merely to restrain others from making and using for a limited period a certain device covered by a patent, whereas it is clear that patent laws were originally framed with an entirely different conception of the rights of the inventor. The question of patent right has an entirely different aspect whether we examine it from the point of view of exclusive right to make or use for a number of years, or of a right not to use it but at the same time prevent the whole world from using and deriving benefits from the invention as well. The inventor is given a monopoly by patent with the idea of encouraging him to expend energy and capital in its perfection, and to benefit the public by his invention, he himself being assured a reasonable profit for a reasonable number of years. The idea of permitting an absolute monopoly of a patent, even though the patentee or owner of the patent refuses to make any use of it whatsoever, is very similar to our harmful and vicious policy of legalizing monopolies in natural resources with the result of benefiting a few who render no service to the community at the expense of the community itself. From a moral point of view there can be no exclusive right to a patent, excepting if it be used, any more than there can be exclusive right to the bounties of nature, excepting if they be put to their best use, so that they benefit the community at large.

* * *

AUTOGENOUS WELDING.

During the last ten years several interesting and valuable processes for joining metal parts have been developed. The processes of welding, soldering, and brazing are very old, having been used from time immemorial. Welding is applicable only to the joining of wrought iron, low carbon steel and a few alloys. For the sake of accuracy we must except gold which in the pure, clean, annealed state has the curious property of welding cold under pressure; but commercially speaking, welding is limited to wrought iron and mild steel. Soldering can be used only on small, light work for joints which are exposed to ordinary temperatures and those slightly above the boiling point of water, inasmuch as the melting point of solder is about 400 degrees F. Brazing, that is, the joining of parts by the fusion of a spelter, is applicable to iron, steel, copper, brass, and other metals. On many kinds of work it is a process rather uncertain in results, even in the hands of experts, unless a good equipment is provided for controlling the heat and manipulating the work.

Until within a few years, cast iron could not be brazed successfully because of the presence of the free carbon in the iron. The brazing of cast iron was made possible by the "ferrofix" process, which first decarbonizes the joint, placing the metal in much the same condition as wrought iron, so far as the action of brazing is concerned, and then brazing follows in the usual manner. Prior to this discovery had been developed the Thompson electric welding process, by which almost all commercial metals except cast iron are quickly and homogeneously welded together, the joint being raised to incandescence by the flow of the electric current. This process has had a very successful commercial development, and now is used for making thousands of welds daily. It and the other electric welding processes are essentially autogenous, as will be explained further on.

The thermit process developed by Goldschmidt was unique. Intense heat is produced by the chemical reaction of pure aluminum and iron oxide in a finely divided state, the temperature rising as high as 5,400 degrees F. One product of the reaction is pure molten iron or mild steel so hot that when poured upon the broken ends of a forging, surrounded by a suitable mold, the parts are instantly melted, and the whole fused together with a mass of hot metal which, as it cools, binds the joint together with a perfectly homogeneous union.

The latest development in the joining of metals, which is now assuming important commercial development, is the so-called autogenous gas flame process. The term autogenous welding is in some danger of becoming applied exclusively to various systems of gas flame welding. The flame produced by the combustion of hydrogen and oxygen, or acetylene and oxygen, is so hot that the parts adjacent to the metal joint are quickly melted together, forming a perfect union. But the meaning of autogenous welding is simply a welding of its own kind, the parts being joined together without the introduction of spelter, solder or any foreign material. Hence any method of joining metals by fusion of the joint which does not require the introduction of foreign material to make the weld, is autogenous. Right here it may be said that the autogenous weld is the only reliable joining of aluminum parts that has been discovered.

An autogenous joint, when properly made, must be as strong as the adjacent metal, provided no change has been made in the characteristics of the metal because of the heat. A broken forging that has been subjected to special heat treatment to improve its physical characteristics could not be autogenously welded and made as strong in the joint as before, without, of course, again being heat treated.

The importance of gas flame autogenous welding in jointing of boilers, drums, receivers and thousands of other manufactured articles, which are now brazed, riveted or bolted together, is obvious. It would seem that a revolution would be worked in the manufacture of steam boilers. The weakness of joints in boilers is more than that of simple reduction of tensile strength. A riveted joint is a section subject to deterioration, because of localized stresses through bending, corrosion and the action of the fire. The ideal boiler shell is that in which every part is as strong as another part, and which is of uniform thickness throughout. The autogenous process bids fair to make the realization of this ideal possible.

* * *

It is stated on good authority that more than a hundred cylinders for the engines ordered in Germany some time ago for the East Indian and the Assam-Bengal Railways were condemned because of faults. Of these, eighty-eight were condemned in one day by the English inspecting engineer at the works. Further, after all the engines were finished, it was found that the transverse framing, a steel casting, ordered outside, would not permit the rocker-arms to work, hence must be replaced. These engines were promised, under fine for delay, to be delivered in May, but were delivered about a year late. The fault in the cylinders was mainly one of the method of casting. It would have been by far better to have cast only one pair of cylinders and tested these both before and after machining, to see if the metal was sound, the coring accurate, and the dimensions correctly given and worked to; then if a fault in any one of these particulars had been discovered, it could have been remedied on the next pair, or if not, at least there would have been less loss on the two trials together than on the eighty-eight. The trouble with the cross-girts was one either of the drawing-room, of the foundry, or of the machine shop; and would have been readily traceable; and in any case a little careful inspection would have revealed that the motion work would not clear, and the engine, consequently, could not make a single turn.

On the same set of engines the safety-valve springs were not of the right length, and a batch of six hundred bolts did not fit their nuts.

All these things reveal the desirability—indeed the necessity—of careful inspection all along the line.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

The increase in the lumber cut in the United States in 1907, over that cut in 1906 was over 7 per cent. The average lumber cut in the United States has increased from 250 feet per capita in 1850, to 480 feet per capita in 1907. There are nearly 30,000 saw mills in the United States.

One of the causes of pin-holes in aluminum castings is, according to the *Brass World*, that the metal is allowed to remain in the fire for some time after it has melted. Aluminum should never be allowed to remain in the fire more than the time required for melting, and overheating should be carefully guarded against if a good casting is expected.

That the aeroplane has been developed to the point of commercial importance is indicated by a cablegram from Le Mans, France, stating that a French syndicate has offered Wilbur Wright $100,000 for the sole right to construct the Wright type of aeroplane in France and the French colonies. It is also alleged that fifty aeroplanes of the Wright model have been ordered and that construction will be begun soon.

A patent has been granted to Henry V. Draper, of Springfield, Mo., for a process of hardening copper. The copper is melted in a crucible, and one pound of alum and four ounces of arsenic are introduced for every 20 pounds of copper. After stirring for some time, the copper is poured. It is claimed that copper thus treated is of great density, toughness and hardness, and that the copper may be melted a number of times without injury.

In the March issue of MACHINERY reference was made to the construction of boats and barges of reinforced concrete in Italy. According to *Engineering News*, reinforced concrete boats similar to those in use in Italy are to be manufactured for use on the Missouri river by Moechel & Lowther Engineering Co., of Kansas City, Mo. This firm has made a model of a 300-ton boat in 1/60 size, and of a 300-ton barge in 1/45 size, each to draw 3½ feet of water for the full-sized boat. Tests made on the models have shown very favorable results, but as yet the large vessels have not been built.

On October 3 the nine-hundred thousandth patent was issued from the U. S. Patent Office. It was an improvement on traveling stairs, such as are used in hotels and other large buildings. Patent Commissioner Moore estimates that the one millionth patent will be issued in the year 1911, and he calls attention to the fact that the total number of patents issued by the United States, is not very far below the total number for all other countries for all time. The issuance of foreign patents up to the date of the last report, was 1,135,000, or only 235,000 in excess of the total for this country.

The construction of the two new White Star liners, previously referred to in MACHINERY, is, we understand, to be commenced in January by Messrs. Harland & Wolff. The definite plans are now laid down. The steamers are to be 860 feet long and of a gross tonnage which is 8,000 tons in excess of that of the *Lusitania* and *Mauretania*. The names of the two vessels will be the *Titanic* and the *Olympic*. There speed is to be practically that of the *Oceanic*, or 21 knots. The first of the two vessels is expected to be ready in about two years, and the second in somewhat less than three years.

The shop structure of the Lucas Machine Tool Co., of Cleveland, Ohio, is built with a saw-tooth roof, and extensions have been made from time to time by adding saw-tooth roof units as the business has grown. To reduce the fire risk, the roof of the last section erected is made of 12 × 18-inch hollow tile, supported by structural steel, and covered with asbestos roofing. The floor is made of cinder concrete about 4 inches in thickness, laid on the natural sand foundation. Two-inch planks are spiked to the concrete, and ⅞-inch maple boards are laid on the planking. This combination makes a shop floor which is believed to be superior to any other construction of equal cost.

The effects of the new British patent law, which provides for the actual working of all British patents within the British Islands, are now commencing to be visible. The law became operative on August 28, 1908. It is stated that 30 foreign firms have completed arrangements to open factories in Great Britain for the working of their patents, and that a number of these are American concerns. Still other firms in the United States and in Germany are negotiating for factories or sites for plants. The principal articles which American firms will manufacture in England are telephones, typewriters, phonographic records, and shoe machinery. It is estimated that about 2,000 patents are now within the scope of the law, and that the effect of the law will be to give employment to from 30,000 to 40,000 people.

The development of scientific instruments, such as the scleroscope and Brinell machine for testing the hardness of metals, may lead to some astonishing and highly desirable discoveries. In an address delivered before the Institution of Civil Engineers, London, Prof. Henry Louis said that one of the greatest needs of the present time in mining is a strong tough metal considerably harder than quartz, which can be used as a substitute for black diamonds or bort for cutting hard rock. It is not impossible, so far as we know, that such a metal will be developed or discovered. Hardness of steel is a quality not fully understood. Manganese steel, for example, resists all steel cutting tools, yet it seemingly is not "hard." It can be bent without fracture and even twisted into corkscrew form. Scientific testing methods may lead to the discovery of steels having as surprisingly superior qualities over those now known as high-speed steel had above the carbon and tungsten steels of a decade ago.

On September 17th, Mr. Orville Wright, who had previously broken the world's records for flights with a heavier-than-air machine, while making a trial flight at Fort Myer, met with an accident which resulted in serious injuries to himself, and the death of Lieut. Selfridge, of the U. S. Signal Corps. The aeroplane was about 75 feet high, when one of the propeller blades broke. Mr. Wright lost control of the machine, which rapidly descended, striking the earth with terrific impact and burying the two men beneath the debris. A few days after the accident the broken blade was brought to Mr. Wright and he discovered an indentation in it which proved conclusively that the accident was due to the propeller coming in contact with a steel stay which was near it, but which was not supposed to be close enough to interfere with its movement. At the time the blade broke the aeroplane was on a curve, and the cause of the tragedy is attributed to this fact, as the machine cannot glide in a curve or spiral.

A paper was presented before the Franklin Institute April 15, 1908, on the theory of shooting, and the evolution of the Spitzer bullet, by L. H. Hartmann. The author briefly traced the evolution of the shoulder arms, mentioning how important is a flat trajectory on the accuracy of shooting. The introduction of smokeless powder by Noble made possible very flat trajectories for long ranges. A further improvement has been made by the Spitzer bullet, which is made with a sharp, approximately conical point, instead of the well known rounded point in common use. So marked is the difference between a round-nose bullet and a Spitzer bullet that the muzzle velocity produced at the same charge in present government rifles is 2,000 feet in the first second with a round-nosed bullet and 2,800 feet with a Spitzer bullet, the gas pressure being 42,000 pounds per square inch. The shape of the point of the Spitzer

bullet in longitudinal section is a sharp ogive. Tests made by the United States government, at Springfield, Mass., confirmed the results that have been experienced abroad.

Lieutenant-Commander Davis, of the United States Navy, has invented a new type of torpedo, which, judging from experiments, will prove very destructive. The torpedo contains a tube of vanadium steel, weighing about 40 pounds, and when the torpedo strikes the side of the vessel a shell is discharged from this tube, through the opening made in the vessel, with a velocity of 600 feet per second. The shell is charged with high explosive and equipped with a time fuse so that when it reaches the interior of the vessel it will explode, doing the greatest possible damage. In this way the protection now given by the water tight compartments, bulkheads and layers of coal will be overcome, and the vessel damaged very much more than when the explosion takes place on or near the exterior. In a trial at Sheep Island in Massachusetts Bay, a torpedo of this type was sent 120 feet to a steel tank 15 feet in diameter, with three bulkheads of ⅝-inch plate, and the torpedo shell passed entirely through the tank and bulkheads, going 100 feet beyond. There was no explosive in the shell used in this trial.

It has been stated by newspaper reports that Professor Wood, of Johns Hopkins University, has designed a new type of astronomical telescope, by means of which he expects to obtain results far in advance of any obtained by telescopes of ordinary construction. The principal feature of Professor Wood's telescope is the mirror, which consists of a basin of mercury set spinning by means of an electric motor. The mercury in the basin assumes a concave surface when the basin is rotated, the concavity being proportional to the speed. The surface obtained is theoretically more correct and brighter than that of any ordinary reflector. By varying the speed of the basin it is possible to alter the focal length of the instrument at will. The only difficulty, so far, has been the impossibility of eliminating slight vibrations of the machine, so as to preserve an absolutely perfect surface of the mercury. At the present time Professor Wood is having a telescope constructed with a 7-inch reflector, and if the instrument fulfils his expectations, it is stated that he will proceed to construct a giant telescope along the same lines.

The beneficial effect of reforestation on water power is vividly illustrated in the case of Miller's River, Mass. A number of concerns, including the L. S. Starrett Co. and the Union Twist Drill Co., of Athol, Mass., have water power derived from this river, and both concerns have auxiliary steam power to help out during the dry season. A few years ago the water would fail almost entirely in July and August, requiring the maximum capacity of the steam plants to run the works, but during the last two or three years the volume of flow has been almost equal to the normal demand for power during the whole summer, and the steam power has been required for a minimum period. The reforestation of the uplands of the drainage area that has been going on rapidly during the last twenty or twenty-five years has restored the old conditions, and now the rain-fall is held back by the trees, shrubbery, leaves and moss, the whole acting like a huge sponge to absorb and feed out the water instead of precipitating it at once into the water courses. In our generation it is common experience that water power, except on large rivers, is very uncertain and unreliable, but with reforestation of the upland areas we may see our streams in a few years restored to the equable flow all the year round that existed in the days of the early settlers. The benefit of conserving forests on the uplands and replanting lumber areas cannot be over-estimated from almost any point of view.

An electric recording target, designed by Mr. Sydney A. M. Rose, A.M., I.E.E., which records each shot, or series of shots, accurately and automatically, is, according to *Engineering*, being introduced by the Rose Recording Target Co., Ltd., 14 Abchurch-lane, E. C. It consists of a traveling target of the usual size, in conjunction with a miniature recording replica of same, located at the firing-point; the motions of both the target and replica synchronize, and when the former is hit, a mark is recorded on the corresponding part of the replica. The target consists of a paper or paper-covered canvas band, marked with the required aims, and is actuated by an electric device which unrolls the band on one side and winds it up on the other. The endless series of targets can travel in either direction and operates synchonously a roll of paper at the firing-point on which the records are made. Across this paper, and at right angles to the direction in which it travels, is arranged a set of contact-making devices placed 1/16 inch apart, and for individual firing connected through a resistance and a line-wire to the marking mechanism of the recorder. An auxiliary line-wire is provided for synchronizing purposes. For volley firing the contact-levers are each connected by a separate wire to a corresponding pencil or marker. When the target is being used, any hole passing under the contact devices immediately closes a circuit, thus transmitting and reproducing the hits.

As we mentioned in the September issue of MACHINERY, the state of New York has organized a new division of trade schools in the Education Department, and Mr. Arthur D. Dean has been made chief of this division. This new inauguration in the Education Department of the state is intended to further the organization of two classes of schools: in the first place, factory or apprenticeship schools, which will train men in factories for the various trades; and in the second place, trade schools of the ordinary type. The new schools will be a part of the regular school system, and subject to its management, but the work will not be mingled or confused with the work of the ordinary public schools. The state will make an allotment of $500 to the Board of Education for each of such schools giving instruction to not less than 25 pupils, provided the school is maintained for a minimum period of 40 weeks in one school-year. The state will also contribute an additional $200 for each teacher, after the first, employed in such a school for the same period. Among the rules laid down by the Department of Education is that for these schools no teacher will be approved of who is not a recognized mechanic. It is advised that the system be organized upon an economical footing, it being suggested that often an idle building, erected for a factory, or some other purpose, may be used. All correspondence regarding this new departure will be welcomed by Mr. Dean; address Division of Trade Schools, Education Department, Albany, N. Y.

A test was made August 24 at the Springfield Armory of the noiseless rifle invented by Hiram Percy Maxim. The test demonstrated that the report of a service army rifle was so reduced by the device as to be inaudible at a distance of 150 feet from the person firing. The invention is of a nature similar to the muffler of a gas engine. Its essential parts are a valve that closes the bore of the gun immediately after the projectile has passed the valve. This closure of the valve prevents the sudden expansion of the gases, the gases being emitted slowly. The result is that the characteristic report of a rifle is reduced three-fourths in loudness, it being judged by the officials who were present that the efficiency of the apparatus was about 74 per cent. In the report of the test it is stated that upon firing, the report was like the snapping of one's fingers accompanied by a slight hissing as the gases escaped. The sound of the hammer striking the firing pin was much sharper than the report of the piece. The invention appears to be entirely practicable and it is thought that it will work a revolution in warfare. The firing line of an army equipped with noiseless and smokeless rifles will be very hard to locate, as there will be neither noise nor smoke to guide the observer as to the position of the enemy. A dangerous feature of the new weapon is that it lends itself admirably to the cowardly assassin. With a noiseless gun it will be possible to shoot down a man in the street without alarming the police. On the other hand, as a game gun the new rifle will be highly prized, it being possible with it to shoot an animal without scaring the remainder of the herd, but even that has its drawback as it will tend to make the business of pot-hunting more successful.

MAKING CONCRETE TELEGRAPH POLES.

An interesting process has lately been adopted by an English firm for manufacturing hollow, tapering, concrete telegraph poles as well as pipes for conveying water, gas, oil, etc., under pressure. It has been customary to regard concrete as a material which has to be cast in a mold, but this machine uses the concrete as a plastic material, somewhat like clay, and the poles and pipes are not cast in a mold. In general, the process of manufacturing concrete poles, as described by *Page's Weekly*, is as follows:

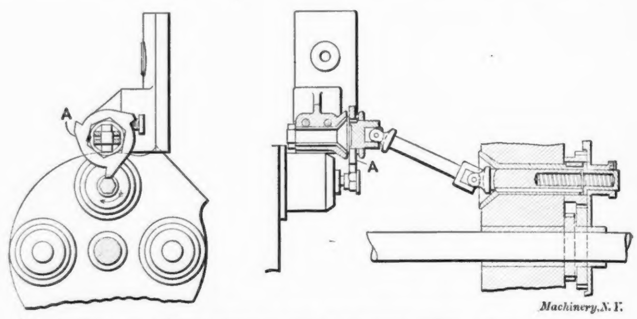
A long core of sheet iron is mounted on two trestles running on rails so as to be capable of rotation and longitudinal movement. Upon this sheet-iron core longitudinal steel rods of small size are fixed. This core is drawn through the machine employed, which is stationary. Concrete made of clean screened grit and Portland cement is discharged into a hopper or drum, in which rotating paddle wheels regularly discharge the concrete upon a bandage of coarse cloth webbing laid on a conveyor belt that takes one lap round the core. This continuous traveling conveyor belt is stretched so that it wraps the concrete round the core under great pressure. As the core issues beyond the conveyor belt, steel wire is fed spirally round it so as to press into the concrete wrapping, and small rollers then apply great pressure by working on the webbing, the slack of which, produced by the reduction in circumference and external diameter resulting from this pressure, is taken up by another contrivance. The core, therefore, as it issues from the machine is wrapped round spirally with a bandage of cloth containing the concrete. The machine pulls the trestles with the suspended core regularly forward, so that the core passes through it as the concrete is wrapped round it, and when the core has passed completely through the machine, it is lifted by an overhead traveling crane and placed on one side for the concrete to harden. In about twelve hours the interior sheet metal core is reduced in diameter by a screw attachment inside and withdrawn from the pole. After hardening for about six days, the bandage of webbing is removed and the pole is then complete. The thickness of the shell of the pole is from one to two inches, according to the height and the strength required, and the reinforcement is likewise varied according to circumstances. Poles are made by the machine above referred to up to 39 feet long, and pipes up to 20 feet long and 2 feet in diameter. Pipes are manufactured in the same way as poles, the smaller pipes withstanding pressures up to twelve atmospheres, and the larger pipes up to six atmospheres.

ATTACHMENT FOR CUTTING SQUARES AND HEXAGONS IN AUTOMATIC SCREW MACHINES.

Practical Engineer, August 7, 1908.

A device has just been patented by Messrs. J. H. Hopkins and H. J. Smith, of Manchester, England, consisting of an attachment for automatic screw machines for cutting flat surfaces, such as squares and hexagons or other polygons, on work produced from a bar, directly in place, so as to save a second handling of the work after leaving the automatic machine. The attachment, as designed, is particularly intended to be applied to a 4-spindle automatic screw machine, and provisions are included for driving a milling cutter of special design, as described later, by means of which flat surfaces are cut, and also for feeding this cutter past the revolving work. It should be understood that the work revolves while the flat surfaces are cut, to provide for which, of course, required some ingenuity in the design. As shown in the illustration, a hexagon is cut on the end of one of the bars in the machine, the cutting tool being the cutter *A*, provided with three teeth. This cutter is placed on a supplementary slide, mounted on the work-carrying head of the machine, and fed by the work by means of a leverage system adjustable to suit the requirements of different work. When the device is in operation, the work and the cutter revolve in the same direction in relation to their axes, so that at the cutting point the directions of the surfaces which are in contact are opposite, but the cutter is geared to revolve at twice the speed of the work to be provided with the hexagon, and as the cutter has three cutting points and revolves very rapidly, it produces a polygon with six equal sides when it has traversed the full width of the flat. If the cutter had only two points, it is clear that a square would be produced. Were a cutter having only one point used, the gearing being the same, two flats only would be produced, and the remaining portion of the circular surface would remain curved. It is clear that the same results can be obtained by gearing of other ratios than two to one, provided the number of teeth in the cutter is selected to suit the ratio of revolutions. The sectional view shows how the drive is transmitted to the cutter from the main drive of the machine.

It may well be remarked in this connection that when any devices are applied to automatic machines which in a certain sense belong outside of the original territory of the machine, it is very important to take into consideration whether these devices require a stoppage of the regular functions of the machine, and thereby rob the machine itself of the efficiency of which it is capable, or whether these extra devices perform their work simultaneously with the performance of certain of the legitimate functions of the tool. In the former case it is often doubtful whether the introduc-



Attachment for Milling Squares and Hexagons while Work is revolving for Other Machining Operations.

tion of such devices is economical. Tying up an automatic machine for such operations as screw slotting, milling, etc., which prevent the continuous working of the machine, is sometimes questionable economy. On the other hand, if the devices are so designed that operations which of necessity must be performed on the machine can still be carried on while the device performs its own functions, then the introduction of such devices is of distinct advantage. If we analyze the conditions attending the device just described we will find that one of its strong features consists in the fact that the work is provided with its flat surfaces while it still continues its rotary motion, thus permitting other cutting tools to perform their functions without interference. There is no stoppage of the machine whatever required. Of course, in the present case another very important fact to consider is that a second handling of the work for milling purposes is saved, and it is often the handling of the work for the performing of various operations, rather than the time occupied by the operations themselves, that determines the cost of the product.

RELATIVE ECONOMY OF STEAM AND GAS POWER WHEN EXHAUST STEAM IS USED FOR HEATING.

F. W. Ballard in the *Engineering News*, August 15, 1907.

The present time offers a good opportunity for making a comparison between the cost of power generated by the gas engine and the cost of power from steam when the conditions are such that either the heating of the building, or the carrying on of some of the processes of manufacture, can be accomplished by the use of exhaust steam from the steam engine. It is generally conceded that when the power alone can be used, and the waste heat from the steam engine and gas engine is not utilized, doubtless the gas engine is the more economical power producer. This can hardly be disputed because not only is the gas engine cheaper as far as fuel consumption is concerned, but in a well-designed gas engine plant the cost of maintenance need not be more than one-half the cost of repairs in a steam power plant of the same capacity, and the total cost of labor for the running of the plant would probably not run very much over one-half what the service would cost in a steam plant. The feature, however, which

gives the steam plant a decided advantage over the gas plant in economy is the possibility of using the exhaust steam from the steam engine for heating. This precludes, of course, the use of the condensing apparatus in connection with the engine, and consequently lowers the economy of the steam plant itself, but since the latent heat contained in exhaust steam amounts to about 80 per cent of the total heat of the steam when going to the engine, the lowering of the efficiency incident to running the engine non-condensing becomes of minor importance. Not only can the exhaust steam be used for heating the whole manufacturing plant, but in addition to the heating of buildings, a great many manufacturing concerns can make use of the heat of the exhaust steam for the carrying on of certain processes necessary in the work, thus saving the use of live steam; and, in cases where the temperature necessary is higher than that of the exhaust steam, it is not only possible, but perfectly feasible, to use the exhaust steam for bringing the temperature up to a certain point, and then to supplement by the use of live steam, thus effecting a great saving of what might otherwise be a very expensive operation.

As examples of uses for exhaust steam, we may mention drying ovens for various kinds of manufacture. If in such cases gas engines were used for power, it would be necessary to operate a special boiler plant to generate steam for drying purposes and for heating. There are also great possibilities along the line of using high-pressure compound engines for power, which can be operated condensing or non-condensing, so that they can be run condensing in the summer time or whenever the exhaust steam is not needed for heating, and operated non-condensing the balance of the time. Of course, there is a possibility of using the exhaust gases from the gas engine for the heating of buildings, but its possibility is very limited, first, because of the low fuel consumption of the gas engine per horse-power hour, and second, because of the large percentage of the heat units contained in the fuel which are converted into power. In a simple non-condensing steam engine we may say that there are about 30,000 heat units contained in the exhaust steam for each horse-power hour, while the waste heat in exhaust gases from the average gas engine would contain only about 6,000 heat units per horse-power hour. In conclusion, therefore, in any comparison between the relative economy of steam and gas power, due consideration must be given to the fact whether or not the exhaust steam from steam engines can be used for heating or other purposes. If it can be so used, the steam engine is likely to be the more economical of the two power producers.

CLUTCHES FOR POWER PRESSES.

Mr. Frank Mossberg, at the June Meeting of the American Society of Mechanical Engineers.

Clutches for power presses must be so constructed as to disengage from the driving wheel and allow the driven shaft to stop in the same fixed position whenever disengagements

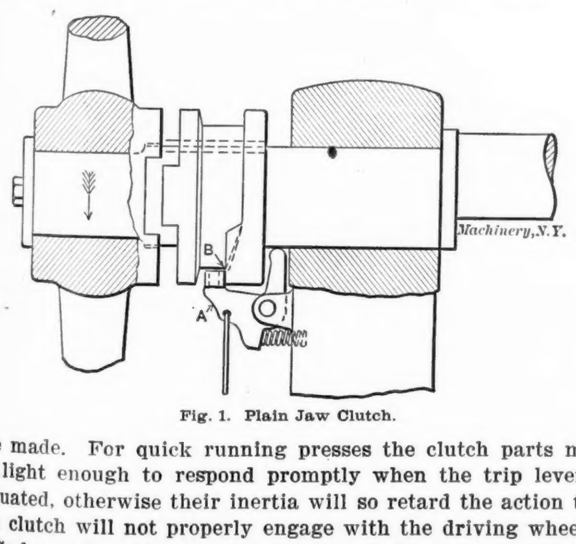


Fig. 1. Plain Jaw Clutch.

are made. For quick running presses the clutch parts must be light enough to respond promptly when the trip lever is actuated, otherwise their inertia will so retard the action that the clutch will not properly engage with the driving wheel.

Perhaps the oldest clutch used for power presses is the simple jaw clutch illustrated in Fig. 1, in which the construction is so fully shown that no explanation is necessary. This clutch, while it may have proved useful for comparatively slow power presses and for light work, has been largely superseded by more improved types. The principal objection to this clutch is its heavy parts, which make it slow to respond, and sometimes when the speed is up to 100 revolutions, difficulty is found in making the clutch jaws enter the driving recesses in the wheel.

Fig. 2 shows a form of clutch used largely by several Connecticut press manufacturers. This consists of a sliding key

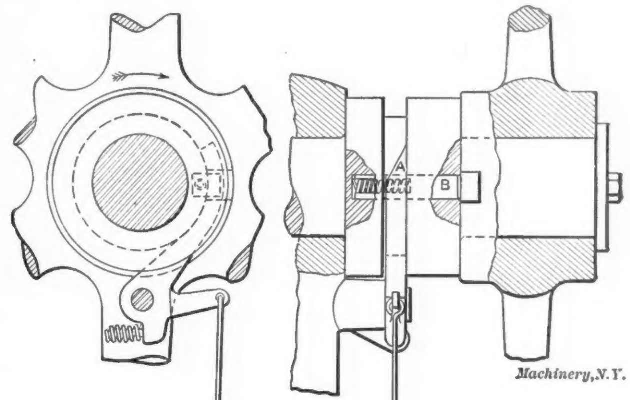


Fig. 2. Sliding Key Clutch.

B fitted to move freely in a slot or pocket in the crank-shaft, and controlled by a wedge shaped cam *A* connected to a treadle or hand lever. To lock the clutch to the driving wheel, the cam is released and the spring forces the key into engagement. Simplicity and low manufacturing cost are points in favor of this clutch, but it requires considerable repairs.

Fig. 3 illustrates a form of clutch used extensively by the Stiles & Parker Press Company, and probably originated by Mr. Stiles. It was developed some thirty years ago, and yet is still used on a large number of presses where it appears to

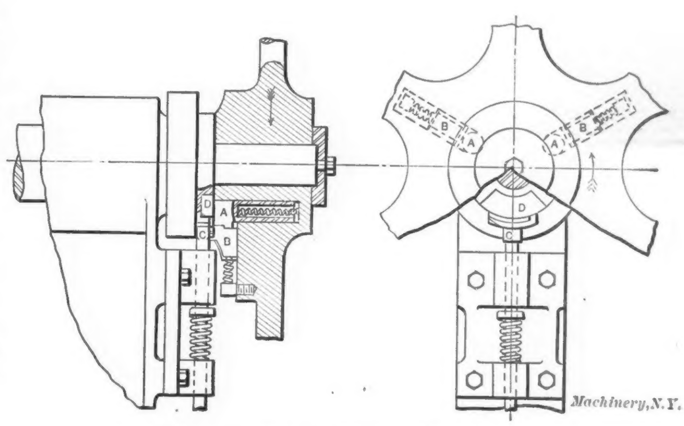


Fig. 3. Stiles & Parker Press Co.'s Clutch.

work satisfactorily. In this clutch the locking pins *A* are located in the driving wheel, and held in position by the trigger block *B*. To operate the clutch the cam segment *C* is slightly depressed. When held in this position the trigger block located in the driving wheel will come in contact with the cam lever, releasing the clutch pin, which in turn drops into recess *D* in the crank shaft. The cam lever is now returned to its normal position, and when the shaft revolves, the clutch pin *A* will be drawn out of the recess of the crank shaft by this same cam, thus stopping the driving shaft in its original position.

Fig. 4 shows a clutch used by one of the large press manufacturers, which commends itself for its simplicity. Owing to the peculiar construction, however, whereby a considerable part of the bearing in the hub of the driving wheel is cut away, the bearing is liable to wear rapidly. Its operation is as follows: The lever *B* is swung out of contact with clutch arm *C*, allowing clutch arm and key to be acted upon by the spiral spring shown in dotted lines. The continual revolution of the driving wheel will promptly bring one of the recesses

E in front of the half round locking key, allowing this key to make one-fourth turn in its socket and thus lock the driving wheel to the shaft. When the shaft reaches the original point of starting, the clutch lever *B* being in its normal position will obstruct the clutch lever *C* and cause the clutch key to return to its original position, allowing the driving wheel to pass over it freely.

Fig. 5 shows a form of clutch used on presses made by the Stiles & Fladd Press Company. The clutch pin *B* in this construction is placed in a pocket in the driving shaft in which it moves radially. A spring forces this pin outward to engage with a lug in the driving wheel when the release lever is actuated. This actuating mechanism will also cause the clutch pin to recede into the pocket in which it is held by the releasing cam out of contact with the driving wheels. This clutch, having two or more contact points in the driving wheels, is a very satisfactory working mechanism, and has proved very durable.

Fig. 6 shows a form of clutch used by the Ferracute Machine Co., and designed by Mr. Oberlin Smith. This clutch is used to a large extent on punching presses. It is rather complicated, especially in the form applied to larger presses. A desirable feature is that it is usually made with several contact points in the driving wheel which are of tempered tool steel. These contact points are so constructed that when the clutch is engaged, the wheel is locked in both directions. The illustration shows the working of this clutch.

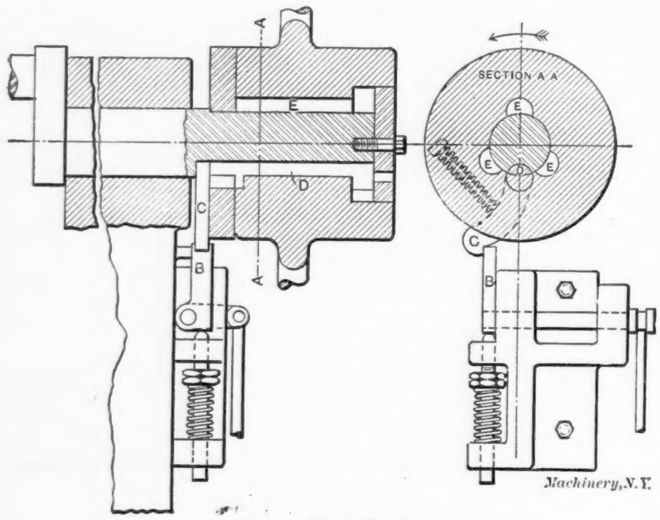


Fig. 4. Bliss Clutch.

Fig. 7 shows a form of clutch designed by the author and intended especially for large presses. It has two large engaging pins of tempered tool steel, which act together. These are located radially opposite each other and far enough from the center for good leverage. This clutch can be made to connect at each half revolution of the driving wheel. It is one of the strongest made and has proved serviceable in practice, requiring very little repairs. The clutch pins *G* connected with sliding collar *C* are mounted to move freely, and revolve with the driving wheel at all times. To operate the clutch, the locking pin *E* is pulled out off the cam *D*, allowing the collar *C* and pins *G* to move into engagement with the clutch lugs *H*, which lock the driving wheel and the shaft together. When the shaft returns to its original position the clutch pins are withdrawn by the action of the cam *D*.

A total departure from all the clutches previously described is a clutch invented by Mr. James A. Horton, of Boston, some years ago. Fig. 9 shows this clutch, which consists mainly of a hardened steel cam *A* keyed to the crank-shaft; a clutch ring *C* mounted to turn slightly on the shaft; a series of rollers *B* held loosely in slots in the ring, and a spring *G* acting on the clutch ring and causing the same to turn, carrying with it the rollers *B* towards the high point of the clutch cam *A*. The balance wheel is recessed to receive this clutch mechanism, this recess being lined with a hardened tool steel ring *D*. The diameter of the recess is such that when the rollers *B* reach a point about half way between the lowest and highest point of the cam they come in contact with the clutch ring *D*, and act as wedges to lock the clutch. Release of the clutch is made when the lug *F*, fastened to the clutch ring, strikes against the stop lever *E*. This will throw the clutch rollers out of engagement and allow the wheel to pass freely. This clutch we may term as a positive friction clutch. It is instantaneous in its action and can readily be disengaged at any predetermined position on the shaft.

A desirable feature peculiar to this clutch is that it can be released with ease under full load. In other words, with

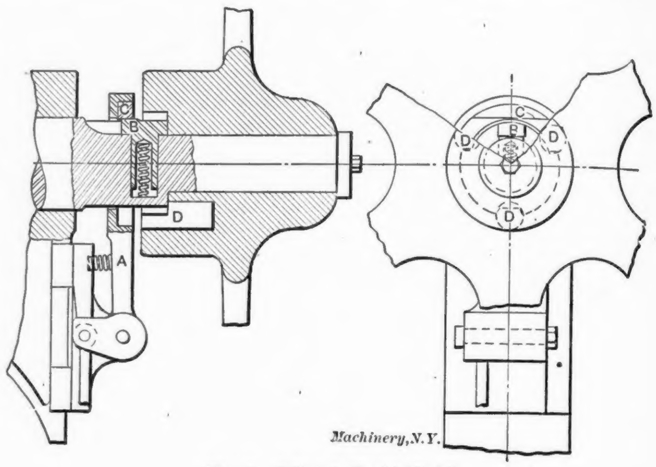


Fig. 5. Stiles & Fladd Clutch.

this clutch it is possible to cause the slide of the press to descend on the work such as in embossing; release the clutch when the embossing dies act on the work; and then when the desired time has elapsed for the embossing tools to act, again engage the clutch and cause the press slide to return to its normal or up position.

This clutch has been extensively used for power presses by the Standard Machinery Company of Providence, R. I., and is one of the most durable forms yet produced for this purpose. It is suitable for the lightest as well as the heaviest press made and works well for speeds from the slowest to 500 R.P.M. The instantaneous action of this clutch when the trip lever is actuated enables the operator to run a press fitted with it faster and keep more perfect time than with any other. In the ordinary clutch, the operator presses the treadle which actuates the fixed locking or catching key. The balance wheel is revolving around the shaft and may be just past the locking point, requiring almost an entire revolution to return to the fixed point in the wheel, while at another time the fixed point in the wheel is in such a position as to engage the locking point instantly; thus we have

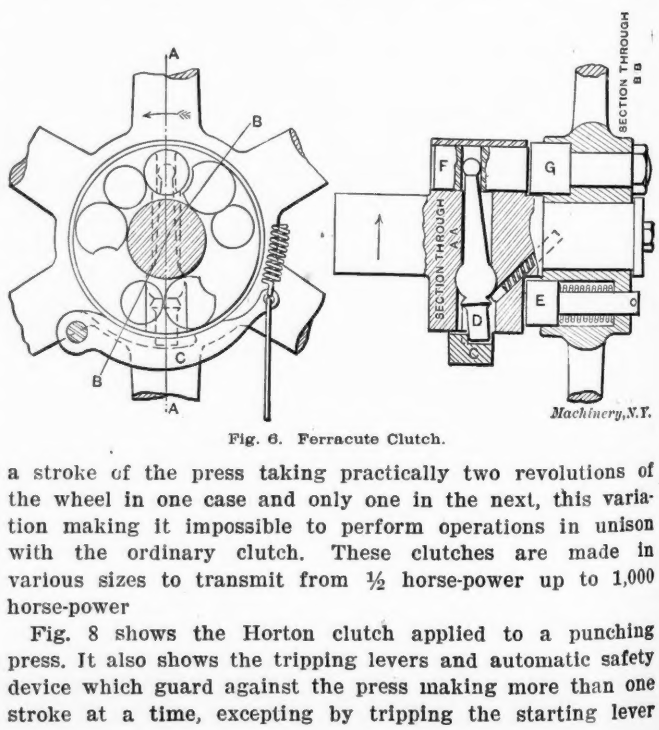


Fig. 6. Ferracute Clutch.

a stroke of the press taking practically two revolutions of the wheel in one case and only one in the next, this variation making it impossible to perform operations in unison with the ordinary clutch. These clutches are made in various sizes to transmit from ½ horse-power up to 1,000 horse-power

Fig. 8 shows the Horton clutch applied to a punching press. It also shows the tripping levers and automatic safety device which guard against the press making more than one stroke at a time, excepting by tripping the starting lever

for each stroke. To make the press run continuously, the clamp *D* is raised to the top of the vertical rod shown and fastened with a thumb screw. The operation and function of the mechanism is so plain that detailed explanation is unnecessary. The safety device described is only one of many for use in connection with a press and a press clutch and by no means confined to the Horton clutch. The high speed at which small hand operated presses are run makes such a device very desirable for the protection of the operator's hands and fingers. Without it a press will frequently make a second stroke unexpectedly, when the operator is putting in or removing from the dies the piece which has been operated upon, and this is the time when accidents usually happen. Small presses run at a high speed, and fed by hand, especially, should be provided with clutches that will not start the press until the operating lever is tripped.

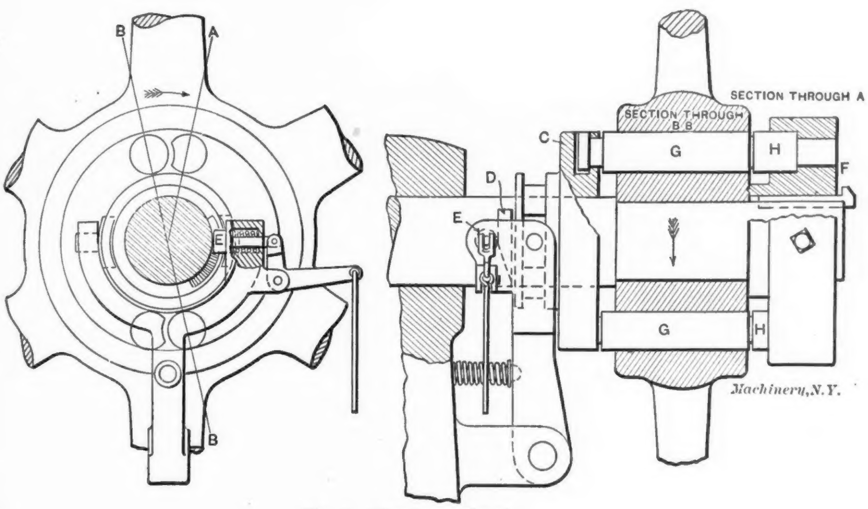


Fig. 7. Mossberg Clutch.

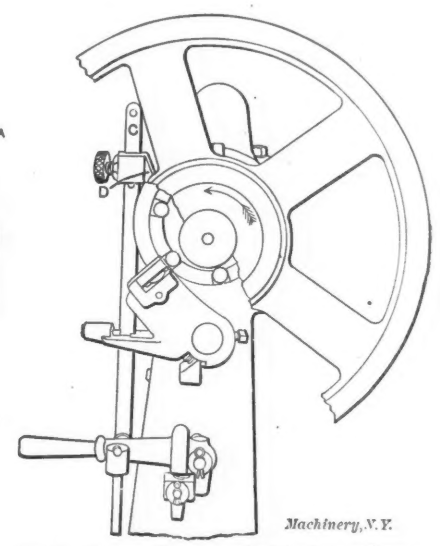


Fig. 8. Horton Clutch applied to Power Press.

Press clutches must endure exceptional strain and abuse. Often a press with its heavy fly wheel will be brought to a standstill by the operator's placing the work in the die in such a way that the press cannot make the full stroke. With a fly wheel weighing seven or eight hundred pounds and 30 to 40 inches in diameter, the strain on the clutch is enormous; but a clutch that will not stand this abuse occasionally, without breaking, is not considered desirable or practicable. Several of the clutches described are capable of meeting these conditions.

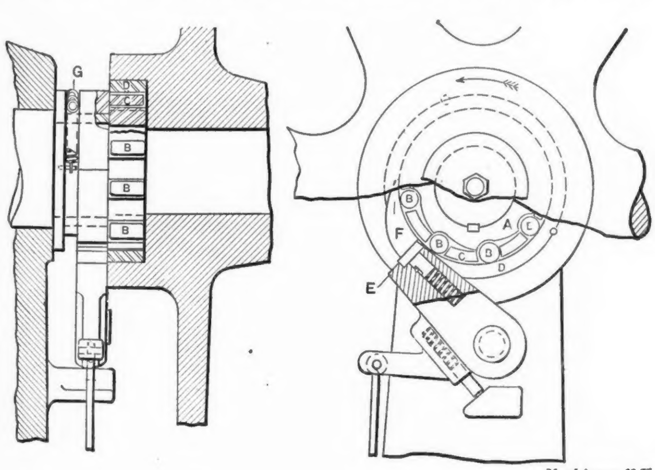


Fig. 9. Design of Horton Clutch.

* * *

Reference was made some time ago in MACHINERY to the trackless trolleys in operation in several places in Europe. Such a trolley line has now been projected from Chattanooga, Tenn., to the top of Walden's Ridge, a distance of about fifteen miles. It is stated in the *Engineering News* that the cars, will carry thirty passengers, and each have starting arrangements similar to that of an ordinary automobile.

CALCULATIONS FOR CONE DRIVE AND BACK-GEAR DESIGN.

ALBERT CLEGG.*

One of the first problems met with in the design of a machine tool is that of determining suitable spindle speeds. In a correct design the various speeds must have a fixed relation to each other, this relation being that of geometrical progression, and the problem is to find the intermediate speeds, the various diameters of the cone steps, and the back-gear ratio, when the slowest and fastest speed and the diameter of one of the cone steps are given. The calculations for finding these speeds are rather lengthy, and the machine designer will no doubt appreciate any method which permits him to save time and work in the laying out of his drive. The table given in the current Supplement will be found to be very valuable for this kind of work. This table gives a number of geometrical progressions ranging from speeds decreasing by 15 per cent to speeds decreasing by 50 per cent.

The simplest way to describe the advantages of this table will be by a practical example. Assume that the spindle of a lathe requires 18 speed changes, varying from 6 to 250 R. P. M., that the cone has three steps, the largest step being 15 inches in diameter, that the lathe is double back-geared, and that a two-speed counter-shaft is provided. The questions to be answered are then: What are the intermediate speeds between 6 and 250 R. P. M.? What are the diameters of the two remaining cone steps? What are the back-gear ratios? and what should be the counter-shaft speeds?

If we turn to the table given in the Supplement, we will find that the maximum speed in every case is given as 1,000, which, in the case of the lathe we are to design, is four times greater than the maximum speed of the spindle. In order to reduce the figures given in the table to correspond with those of our example, we must divide the speeds given in the table by 4 $(1,000 \div 4 = 250)$; our slowest speed, given as 6 R. P. M., will then correspond to a speed given in the table equal to 24 R. P. M. $(24 \div 4 = 6)$. It will be seen that 24 and 1,000 are in exactly the same ratio as 6 and 250. The number of spindle speeds being 18, we now follow the horizontal line from the figure 18 in the left-hand column of the table, until we reach the number nearest to 24, this number in this case being 22.5 in the 20 per cent column. The figures in this column, divided by 4, will give us the range of the speeds desired, these speeds being as follows:

250	65.5	17.17
200	52.5	13.7
160	42	11
128	33.5	8.8
102.5	26.75	7.04
82	21.5	5.62

The speed ratio for the first back-gears is obtained by dividing 250, the fastest open belt speed, by 65.5, the fastest first

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back-gear speed; and the second back-gear ratio is found by dividing 250, the fastest open belt speed, by 17.17, the fastest second back-gear speed. These two ratios are then found to be 3.82 to 1, and 14.6 to 1, respectively. The counter-shaft speeds will be found to be 200 and 102.5 (the speeds of the middle cone steps), if consecutive spindle speeds are obtained by moving the belt from one step on the cone to another; but if consecutive speeds are obtained by shifting the counter-shaft, then this latter would be required to run at 160 and 128 R. P. M., which would then be the speeds of the middle cone steps. The diameter of the smallest cone step, if consecutive speeds are obtained by changing the counter-shaft speed, will equal $\frac{15 \times 160}{250} = 9.6$ inches. The diameter of the middle step would then be 12.3 inches. It will be seen that the table in the Supplement diminishes the actual work required for calculating geometrical speed progressions to a large extent, and that the various quantities to be settled upon can be determined with very little arithmetical work.

If it be required to lay out a drive with four cone steps instead of three, the calculations for the counter-shaft speeds, of course, become a little more complicated, as there is then no middle cone step, but the use of the table for finding spindle speeds, and back-gear ratios will eliminate a great amount of work even in this case.

* * *

COMPUTATION TABLE FOR REGULAR POLYGONS.

W. L. BENITZ.*

The object of the two tables relating to regular polygons, in the Supplement, is to simplify the necessary calculations for any required dimensions of polygons. If the area, or any dimension of a regular polygon of a specified number of sides, is given, all the other dimensions are thereby determined in amount, and the proportion which the known part bears to each of the unknown parts will vary with the number of sides of the polygon. A knowledge of trigonometry is a requisite in determining the required proportions of these parts, and the accompanying tables were prepared not only to facilitate the trigonometrical work, but, at the same time, to simplify the process down to plain multiplication, or, where the area is the given dimension, to the extraction of a square root. The case in which the number of sides is required cannot be directly solved by elementary trigonometry, but is easily found by means of the tables.

Table I in the Supplement gives the symbols by which the various parts are designated, as well as all the necessary formulas needed for any computation. In addition to the symbols indicated at the top of Table I, there appear the letters B, F, M, K, and H, which are calculated in Table II for the proper value of N, the number of sides of the polygon, which heads the first column. These letters represent the following quantities: $F = N \tan \frac{180°}{N}$; $M = 2N \sin \frac{180°}{N}$; $B = \frac{1}{N} \operatorname{cosec} \frac{180°}{N}$; $K = \frac{N}{4} \cot \frac{180°}{N}$; $H = \frac{N}{8} \sin \frac{360°}{N}$. The logarithms of these quantities are given in each succeeding column for convenience in logarithmic calculation. The use of the tables may be partly illustrated by the following simple applications.

Example 1.—What size octagon steel will have a sectional area of 2 square inches?

We know $A = 2$, $N = 8$, and must find d. In Table I and in the column headed A, we run down the column until we find d on the left-hand side of the equation, giving the formula $d = \frac{4\sqrt{AK}}{N}$. The value of K is taken from Table II in the line beginning with $N = 8$, giving us $K = 4.82843$. Substituting these values of A, K, and N in the formula gives:

$$d = \frac{4\sqrt{2 \times 4.82843}}{8} = \frac{\sqrt{9.65686}}{2} = 1.554 \text{ inch, which is the}$$

proper distance across the flats to give a sectional area of 2 square inches.

Example 2.—What is the size of the round bar from which the octagon bar of the preceding example could be milled?

It is now required to find D, with $N = 8$, as before, and $A = 2$, or we may use $d = 1.554$, as already found. If the latter is selected we know d, and selecting the last formula in the column headed d from Table I gives $D = BFd$. B and F are selected as before, but if we use logarithms this time we will take our values from the tabulated logarithms of those quantities, giving us in the line for $N = 8$, Table II, log. $B = \bar{1}.51407$; log. $F = 0.52031$; and log. $1.554 = 0.19145$, from table of logarithms.

Then log. $D = \log. B + \log. F + \log. d = \bar{1}.51407 + 0.52031 + 0.19145 = 0.22583$, and $D = 1.682$ inch.

Example 3.—What is the area of a segment of a circle, 66 inches in diameter, lying between the circumference and one side of an inscribed polygon of 5 sides? The area required, which is similar to the shaded area in the figure of Table I in the Supplement, will be one-fifth of the difference in areas between the circle and the inscribed polygon. Knowing D, we find the area of the polygon from the formula $A = HD^2$, using the value of H for $N = 5$, which is 0.59441. The area of the polygon is then $A = (66)^2\ 0.59441 = 2589.3$ square inches. The area of the circle is $\frac{\pi}{4}(66)^2 = 3421.2$ square inches. Taking one-fifth of the difference we have

$$\text{Area of segment} = \frac{3421.2 - 2589.3}{5} = 166.38 \text{ square inches.}$$

Example 4.—If each side of a polygon is 4 inches long, how many sides must it have to make the area 99 square inches?

In this case both C and A are known and N is to be determined. Selecting the formula for A when C is known, we have $A = KC^2$, and solving for K gives $K = \frac{A}{C^2}$. Substituting the known values of A and C we have $K = \frac{99}{(4)^2} = \frac{99}{16} = 6.1875$. Running down the column headed K in Table II, we find the nearest value to this is 6.18182, which corresponds to the value 9 for N. The figure would then have 9 sides.

These are only a few of the many applications that may be made of the tables, and as indicated by the number of formulas, there may be twenty different problems stated, all of which are taken care of. These formulas and tables are also adapted to the solution of isosceles triangles in which the vertical angle approximates that in column Z, Table II.

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TWO-CYCLE AND FOUR-CYCLE GAS ENGINES.

The growing importance of the gas engine as a motive power for all services makes the application of the terms "two-cycle" and "four-cycle" peculiarly aggravating misnomers. The word "cycle" means a chain of events that follow one after another until completion, when the same chain of events is repeated. In the action of the so-called four-cycle engine, the mixture of atmosphere and combustible gas is drawn into the cylinder by the induction stroke. The next stroke of the piston compresses the mixture of combustible gas and air into the clearance space of the cylinder, where it is exploded by a spark. The next stroke is the power stroke, following which is the stroke which exhausts the spent gases from the cylinder. Following this stroke is the induction stroke again. Thus four strokes of the pistons are required to complete the cycle.

In the two-cycle engine there is the induction stroke and the firing stroke, only two strokes being required to complete the cycle, the exhaust gases being expelled at the same time that a new charge is forced into the cylinder. The particular descriptive terms which apply to the two types of internal combustion motors and which are coming into use to some extent are "two-stroke cycle" and "four-stroke cycle," these terms clearly describing the action of the respective types.

GRINDING THREADING CHASERS FOR BRASS WORK.

ETHAN VIALL.*

From time to time a correspondent will tell of his trouble in obtaining a smooth thread on machine or tool steel when using the self-opening type of die heads; but when a person has been working with tools of this description on brass of varying grades of hardness he comes to the conclusion that dealing with machine or tool steel is what might be

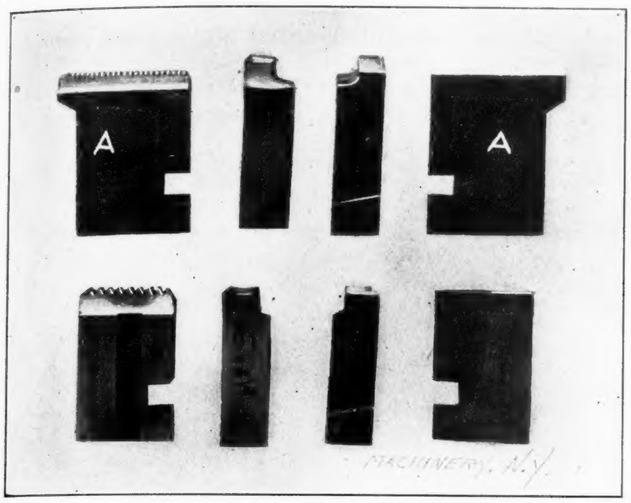

Fig. 1. Threading Die Chasers used for Brass Work.

called a "soft snap." When the brass worked upon is reasonably uniform, the difficulty of grinding threading dies to suit the work is not so pronounced. But when all kinds of brass, scrap as well as new brass, is used, only long experience will enable a man to sharpen the thread cutting chasers so that they will give satisfaction. Definite rules that will

Figs. 2 to 11. Different Ways of Grinding Rake and Chamfer on Threading Die Chasers.

cover all cases cannot be laid down, but a few general principles applying to the grinding of these tools may be of value.

That difficulties will arise on account of ununiformity in the texture of the brass to be worked upon is, of course, evident. Another difficulty to be contended with is the wear of the die heads. When the die heads are new the chasers are held reasonably solid, but when the heads wear, the chasers become loose and must be ground so that they will not dig into the brass and produce a torn or imperfect thread. In the following the writer will describe the practice of grinding chasers in a certain shop where a great deal of this work is done. All chasers used in this shop are made in the tool-room from Jessop steel, and the threads are cut and relieved on Hendey-Norton lathes. They are then hardened and sent to the grinding room to be sharpened. The first cost of the chasers is higher than that for which they could be bought from firms making a business of die making, but these chasers give better satisfaction than any that could be obtained in the market, and besides, any faults discovered in actual use may be corrected in the next lot, which is not the case when the chasers are purchased.

In making brass chasers it is absolutely necessary that the threads be relieved; otherwise clogging will result. In the class of work just referred to, most of the threads are run up close to a shoulder, and, as a consequence, a very sharp

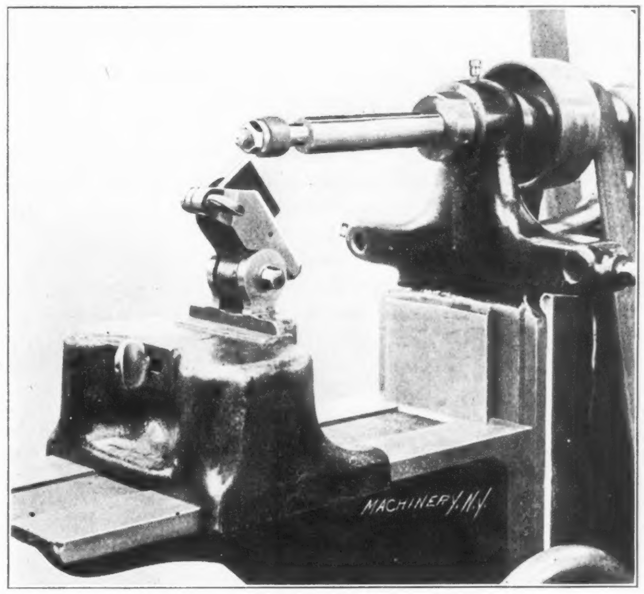

Fig. 12. Grinding the Chamfer on the Chaser.

chamfer must be ground on the chasers. It is not good policy to grind the chamfer any oftener than is absolutely necessary, because each grinding of the chamfer will shorten the life of the chasers in those cases where the die cuts close to a shoulder. When chasers show a tendency to break off at the chamfer or to get dull quickly at this place, they may be made with an extension as shown at *A* in Fig. 1. When made in this way the chasers are usually worn out by the time the extensions are ground off flush with the face of the body.

Referring now to the principle of grinding thread chasers, a number of conditions are shown in Figs. 2 to 11. Our discussion will probably be clearer if for the time being we consider the chasers as lathe tools. In Fig. 2 is shown a chaser with milled threads. This is extremely difficult to use on brass work. When ground as shown at *c* it will dig into the work; when ground down still further as at *d* it still has the same tendency. To grind it as shown at *a* and *b* would produce impossible angles for brass work. In Fig. 3, *a*, *b*, and *c* are the same angles as *c* and *d* in Fig. 2, and *d* and *e* show the teeth ground without rake. When ground as shown at *d*, the cutting edge being on the center line, the tool has still a tendency to dig in. If ground as at *e*, it is obvious that this angle is undesirable. The writer's experience points toward the fact that it is useless to experiment with this kind of chaser on brass work, as it is impossible to grind it so as to be able to use it any great length of time.

Fig. 4 shows a chaser ground to angles advantageous for very hard brass. The angle is so determined that the face of the cutting edge is 1/8 inch ahead of the center at the successive grindings. In Fig. 5 the chaser is ground with a negative rake, the cutting edge being 1-16 below the center. This

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is used occasionally for certain classes of work, such as very soft "greasy" brass. In Fig. 6 is shown a chaser ground in a way to give the best satisfaction for all-around work. The cutting edge is ground so that a line passing through the face also passes through the center of the work. Finally, in Fig. 7 is shown a very poor way to grind a chaser whether for brass or steel, as the angle of the cutting point changes with each successive grinding, and while such a chaser may cut satisfactorily on some work when nearly new, it is not likely to do so after one or two grindings.

In grinding the chamfer on a brass cutting chaser a wheel about the size of, or very slightly larger than, the piece which the chaser is intended to cut, should be used. The relation of the wheel to the chaser when grinding the chamfer is indicated in Figs. 8 and 9. In Fig. 8, *b* represents the stock to be cut, and *a* the emery wheel used for grinding the relief of the chamfer. As will be seen, the center of the emery wheel is a trifle below the center of the stock, and somewhat toward the right. In Fig. 9 is shown the relation when grinding a chaser for hard brass, such as shown in Fig. 4. Extreme care must be taken, in grinding, not to draw the cutting edge or chamfer of the teeth.

In Fig. 10 is indicated the angle at which the chaser should be set in the fixture when grinding the chamfer for a uniform run of thread cutting. Fig. 11 gives a little more bevel or angle of chamfer. As a general rule, except for the very hardest brass, as little relief as possible back of the cutting edge of the chamfer should be used, as it steadies the chasers when starting the thread. It is of advantage when grinding new chasers to set the chaser well over to the left of the wheel, using a fixture such as shown in Fig. 12, and just touch the edge of the chamfer furthest away from the cutting edge, with the wheel; then gradually move the wheel over until there is a slight relief all the way up to the cutting edge. A fixture or jig used for grinding the faces of chasers is

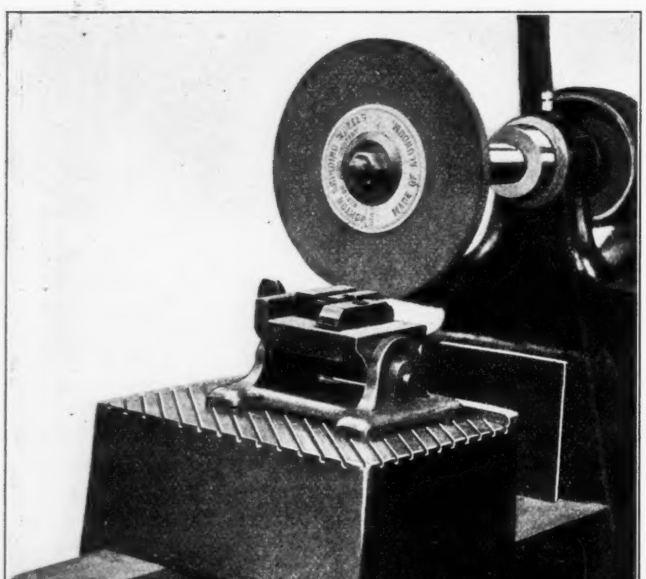
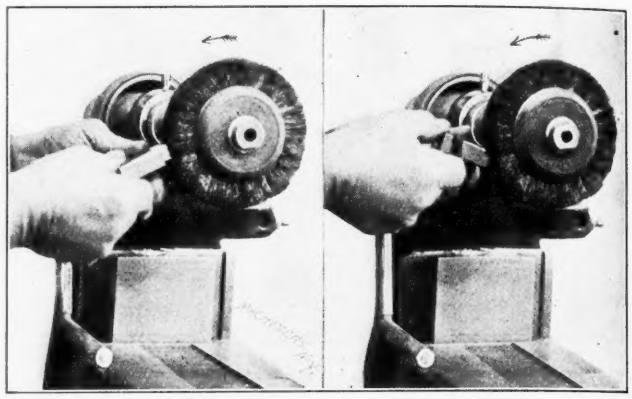


Fig. 13. Grinding the Cutting Edge of the Chaser.

shown in Fig. 13. Both of these fixtures are made by an outside company (The Modern Tool Co., Erie., Pa.) especially for this purpose. It is necessary to use some kind of a fixture, as it is impossible to get good results when chasers are ground by hand.

Alundum wheels of rather fine grade and known as elastic bond, have given better satisfaction for grinding chasers than any other wheels, but no matter what wheel is used there is a fin left on the cutting edges of the tool, which is a source of trouble if not removed. Lapping in various ways was tried for removing this fin, but the most satisfactory, as well as the quickest way, is to use a very fine three-cornered file and just draw it lightly down each V-groove of the thread at an angle of about 45 degrees, not pressing hard enough to more than take away the fin and slightly dull the cutting edge. An oil stone should then be run lightly over the edge of the chamfer to dull it just enough, so that it is not entirely sharp. The chaser threads are then dipped in a little flour of emery and oil, and brought up against a wire brush, as shown in Fig. 14. They are then turned over and brought up against the wire brush as shown in Fig. 15. This should be done very lightly, and has the effect of smoothing the edges the right amount. A little practice soon enables one to determine the proper amount for this. The wire brush is 6 inches in diameter, made of fine wire, and runs 3,400 revolutions per minute.

As a rule, a brass cutting chaser will chatter when too sharp. When the thread cut becomes torn, it is evidence that the chasers are dull, or that they feed too fast. Burrs in the thread tend to have the same effect as increasing the



Figs. 14 and 15. Revolving Wire Brushes which smooth the Cutting Edges of the Chaser.

pitch in many cases. Chasers generally tend to feed too fast rather than too slow, and the remedy is the judicious removal of burrs or dulling of the cutting edges, provided, of course, that the teeth are already ground to the right cutting angle. When a set of chasers feed too slow the cause is usually that there is not enough clearance back of the cutting edges of the chamfer. Whether chasers feed too fast or too slow is easily determined by examining the thread cut. If the side of the thread next to the turret is smooth, and the side next to the chuck is torn or ragged, the chasers feed too fast, and vice versa.

* * *

At the October 13 meeting of the gas power section of the American Society of Mechanical Engineers in New York, a plan of action was presented in a paper by Mr. H. L. Doherty. It briefly reviewed the subject of gas power and pointed out some of the fields of activity that are now in embryonic state. He warned the members of the section in regard to unpromising fields and unnecessary duplication of work. Much duplicate work could be avoided if the present state of the gas power art could be quickly brought before the membership and provision made whereby all progress in the state of the art would be quickly reported. As an example of an unpromising field of experiment and invention, Mr. Doherty quoted the so-called gas turbine as distinguished from the mixed turbine, that is, a turbine using both gas and steam. To construct an actual gas turbine on ordinary lines requires the transformation of heat energy to work energy at a temperature and blade velocity beyond the strength of any material now known. In spite of this fact, however, thousands of dollars have been wasted in the vain attempt to solve the problem.

* * *

The general development of the gas engine has taken little account of the heat of the exhaust, the exhaust generally being allowed to go to waste. However, there is a growing disposition now to utilize the exhaust heat for water heating and steam generation. Experiments made abroad indicate that the heat of the exhaust will evaporate from 1.1 to about 1.5 pound of steam per horse-power per hour, or it will raise from 600 to 820 pounds of water from 32 degrees F. to the boiling point. The value of this heat from a large gas engine is apparent.

A PROPELLER PLANING MACHINE.

NOSMOT.

The accompanying half-tones and line engraving illustrate a machine designed to dispense with considerable hand labor in the finishing of large propeller blades. Up to the time that this machine was put in operation, all blades were finished by chipping, grinding with a flexible shaft grinder, scraping and filing, and the time consumed was considerable. The blades were not uniform when thus finished, and consequently did not balance when under pressure.

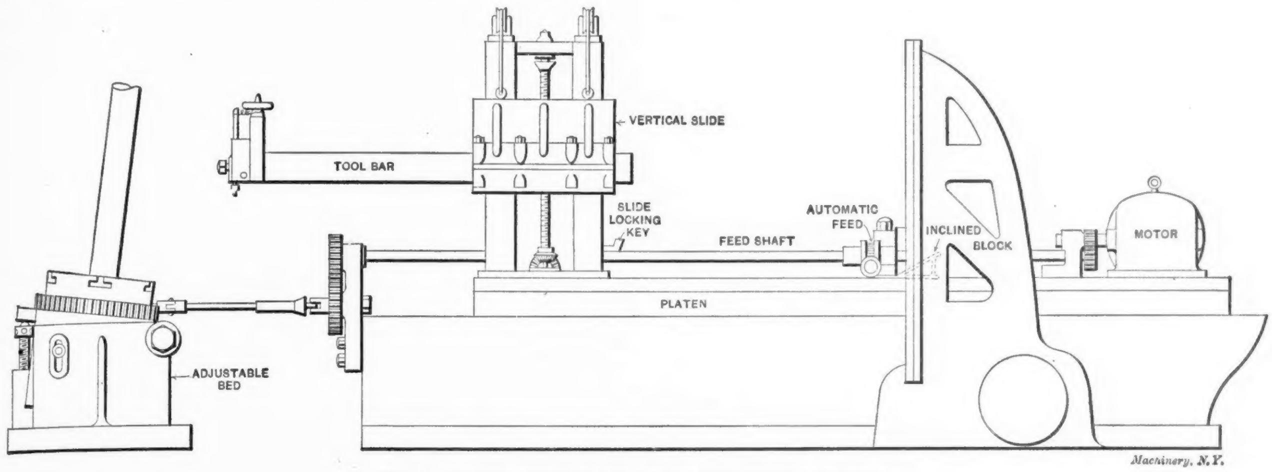


Fig. 1. General Arrangement of Propeller Planing Machine.

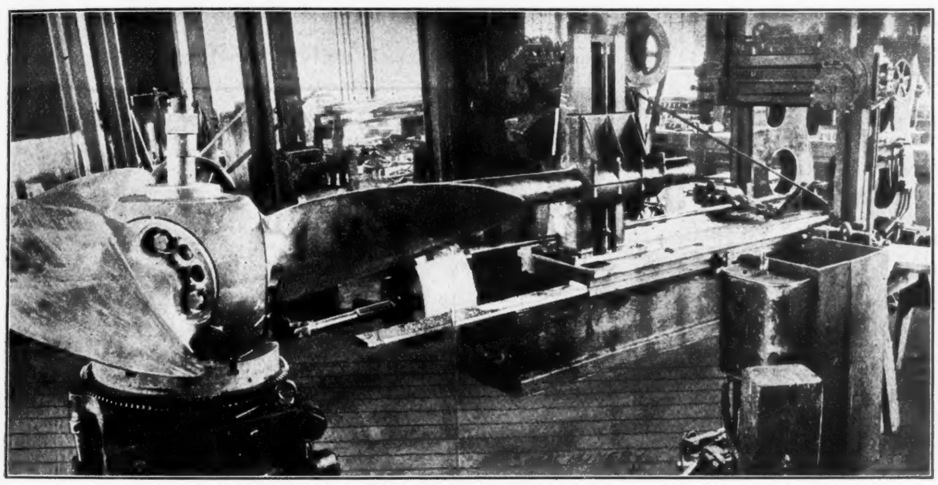


Fig. 2. Propeller Planing Machine in Operation.

The propellers are now cast, the hub bored, and, in the case of the one shown on the machine in Fig. 2, the blades are fitted to the body. The body in this case is finished on the boring mill with the exception of the screw holes, which are drilled and tapped in the radial drill. The blades are tested on the surface plate and the pitch line marked. The shanks are also laid off and prick punched around, after which they are centered in the horizontal boring mill and finished in the lathe.

The blades and body are assembled on the erecting floor and then placed in position on the planing machine. This machine, as shown in Fig. 1, consists of a regular planer on the platen of which is bolted an upright carrying a slide. The tool-carrying bar is fitted into this slide, the vertical movement of which is governed by the lead-screw shown. The slide is balanced by weights at the back of the upright, for the purpose of taking the strain from the screw. A motor driving the feed shaft is also bolted to the platen and used for quickly running the tool either way over the work. A ratchet and pawl arm carrying a roller is bolted onto one of the housings and this, in conjunction with the inclined plane block shown gives an automatic feed. Bevel gearing between the feed shaft and vertical slide screw gives the up and down movement of the tool, at the same time as the propeller is revolved by means of the worm and worm-wheel driven by gearing from the feed shaft. The revolving table is set upon an adjustable bed for the purpose of lining up the tool and its motion to the shape of the propeller and its angular deflection.

The propeller is firmly clamped to the table in such a position that the center of one blade is in line with the tool bar. A key locking the feed shaft to the slide screw is pulled out, and the tool is brought nearly to the surface of the blade. The locking key is then driven in, and the tool passed over the blade. The tool is tried in several positions by a small movement of the planer platen for each, and the adjustable bed inclined until the movement is about in line with the casting. The tool is then moved close to the propeller body and a slot planed around the hub for clearance for the tool, by passing the tool over the blade by the feed motion, the propeller meanwhile rotating; during this the platen remains stationary. When this slot has been cut to a sufficient depth—about 1/8 inch to 1/4 inch deep—the tool is raised to its highest point, ready for operation.

The platen movement is governed in the regular way by stops. It is set in motion, and the tool brought to its cut by the feed shaft motor. The inclined block is set in such a position that the roller will move one or two teeth on the ratchet as desired. All small adjustments are made with the hand-wheel shown on the tool head. Usually two cuts are necessary to finish a blade. The gearing is so arranged that the tool moves down a corresponding distance when the propeller blade rotates around its center. After finishing the first blade, the slide locking key is removed and

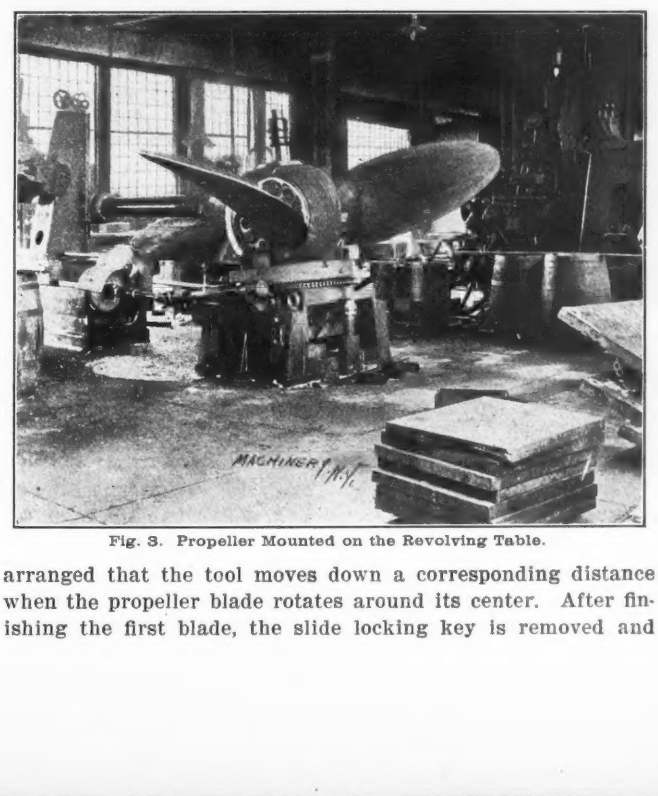


Fig. 3. Propeller Mounted on the Revolving Table.

the propeller revolved by motor into position, after which the operations previously described are carried out.

When finishing the blades, the propeller is carried to the erecting floor, where hand labor is employed to scrape and file-finish the surfaces. As the back is not planed, it takes some time to smooth it, but the face requires very little attention. Ordinary scrapers and bent files are used. Propellers made by this method have been tested and found far superior to those made by any other method known to the writer.

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MACHINING FLY-WHEELS FOR GASOLINE ENGINES ON THE POND RIGID TURRET LATHE.

In the July, 1908, issue of MACHINERY we described and illustrated the operation of finishing automobile fly-wheels on a Libby turret lathe. In the present article a similar class of work is dealt with, the illustrations showing how fly-wheels for gasoline engines are finished all over on a Pond rigid turret lathe. Operations of this kind can be carried out easily on this machine also on account of its construction, which permits the carriage to be run under the chuck, so that wide facing tools may be bolted directly to the broad faces of the turret, thereby making a stiffer arrangement of tools than would otherwise be possible.

The work is finished in two cycles of operations, in the first of which the fly-wheel is turned complete on one side, the

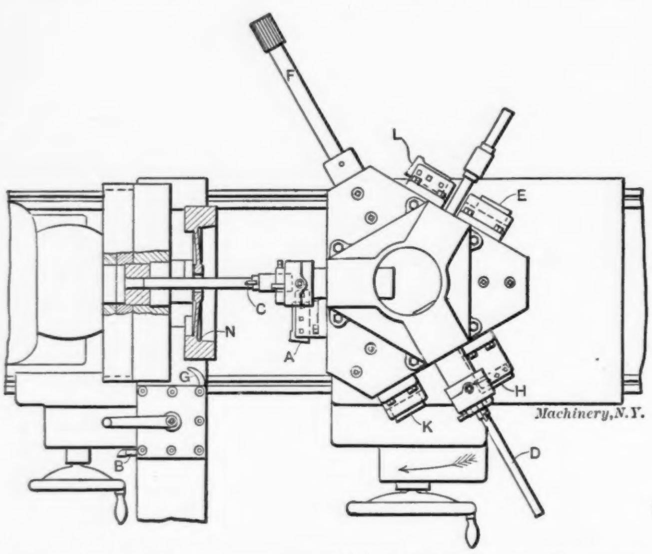


Fig. 1. First Cycle of Operations in Finishing Gasoline Engine Fly-wheels on a Pond Turret Lathe.

hole bored and reamed, and the outside circumference finished; in the second cycle the other side of the fly-wheel is completed. During the first operation, the work is held by the inside of the rim by means of a four-jaw chuck, using the hard jaws. The side of the rim, the tapering circumference of the recess, the web, and the hub are first rough-turned, using tools placed in the carriage tool-post.

The hole is then rough-bored, using the bar *C*, supported in a bushing in the chuck, as shown in Fig. 1. The outside circumference of the wheel is rough-turned at the same time by a cutter, held in the extension turret tool-holder *T*, Fig. 3, and the taper fit on the inside of the fly-wheel is turned by means of cutter *A*, held in a facing head on the turret.

The outside diameter of the wheel is next finish-turned with a finish cutter *V* held in the same manner as the roughing tool for the same operation, in the extension turret tool-holder. At the same time the bore is finished, using a finish boring cutter in boring-bar *D*, supported in the bushing in the chuck in the same manner as the roughing bar *C*. The side of the rim and the hub of the wheel are also finished at this time by two facing cutters *H* and *K*, held in tool-holders on the face of the turret. When the finish cuts on the rim and hub are taken, the work is supported by a bushing on the boring-bar in the bore of the wheel, the boring cutter and facing tools being set in such relation to each other that the finishing boring of the hole is completed before the facing cuts are taken.

The web of the wheel is next finish-faced with the facing cutter held in the holder *E*, and the taper surface on the inside of the rim is finished by the tool *L* at the same time. While these last operations are performed, the work is supported by a bushing held on a supporting arbor, entering the bore of the wheel. In the next step, the bore is reamed, using a reamer held in a floating reamer-holder as shown at *F*. When the reaming operation is completed, a groove *N* is cut on the inside of the rim, using a tool *G* held in the carriage tool-post, as shown. The first cycle of operations on the fly-wheel is now completed.

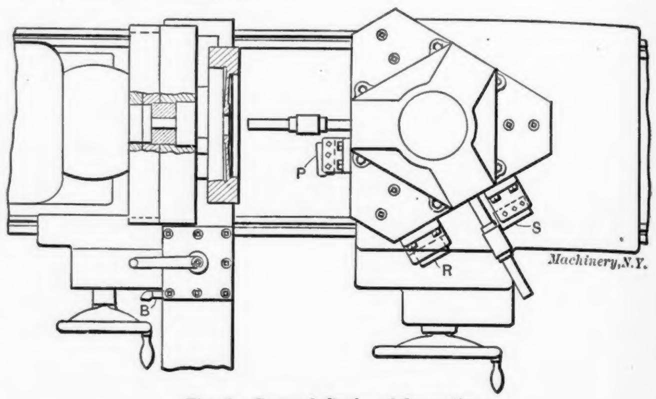


Fig. 2. Second Cycle of Operations.

The fly-wheel is then removed from the chuck, turned around, and held in soft jaws for the second cycle of operations, the jaws fitting the outside circumference of the wheel. The operations on this side are very similar to those performed on the other side, excepting that they are fewer, and therefore less complicated. In the first place, the side face and the inside of the rim, the web, and hub are rough-turned, using tools held in the carriage tool-post. In the next place, the inside of the rim and the web are finished, using the cutters held in the tool-holder *P*, Fig. 2, screwed to the face of the turret. The work is supported during this operation by a bushing held on a supporting arbor, having a pilot supported in a bushing in the chuck, the same as already referred to in the first cycle of operations. Finally the rim and hub are finished, the facing cutters held in the facing heads *R* and *S* being used, the work being supported as before.

The time required for performing these operations is about one hour. It should be noted that the design of the turret lathe permits several cuts to be taken on different parts of the work, simultaneously, thereby saving a great amount of

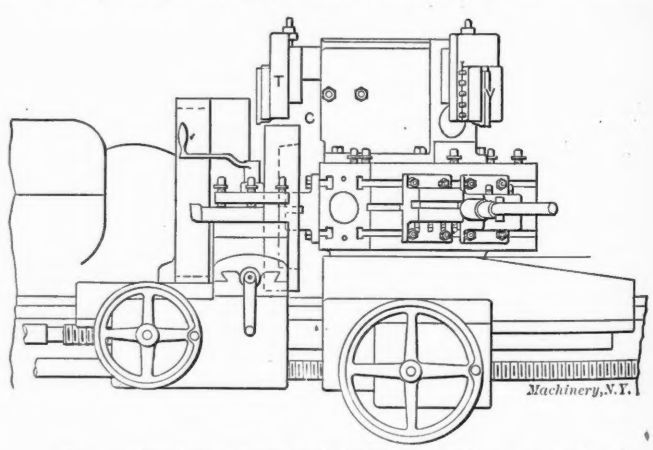


Fig. 3. Elevation of Turret and Tools for Finishing Fly-wheels, First Operation.

time. While these operations are simple, they illustrate in a very practical manner the advanced labor-saving methods employed in automobile factories, and in other shops where large numbers of gasoline engines are built, and also how the cost reduction of machining the fly-wheels has been given special attention.

* * *

Use a keen knife to sharpen lead pencils. The tensile strength of the graphite core is very low, and a dull blade breaks it by pulling it in two, thus causing excessive waste of pencils.

SOME INTERESTING AUTOMATIC SCREW MACHINE WORK.

The automatic screw machine has, during the last few years, proved itself capable of performing a great many operations which but a short time ago were considered as properly belonging to the province of the engine lathe. This is true not only with regard to the size of the work operated upon, but also in regard to the number of operations, and the complication of the design of the piece of work to be machined.

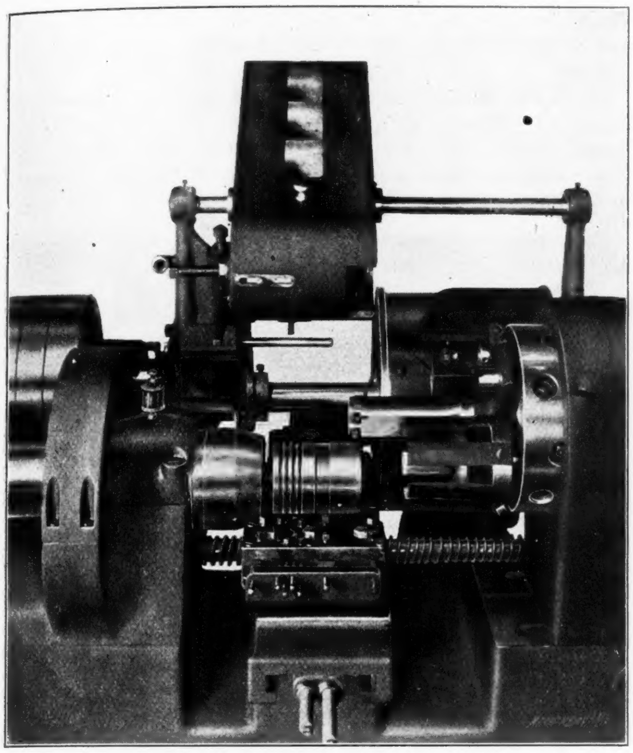


Fig. 1. Cleveland Automatic Screw Machine operating on Piston shown in Fig. 2.

In the present article some interesting work of this class performed on a Cleveland automatic screw machine, manufactured by the Cleveland Automatic Machine Co., Cleveland, O., is illustrated.

In Fig. 2 is shown a section and end view of a piston finished on a Cleveland 2-inch automatic machine in but a small fraction of the time which would be required to turn and bore the same piece by any other method. This piston is made from cast iron, and is finished on the various surfaces, as indicated by the finishing marks in the engraving, in eight minutes, after which, of course, it is ground on the outside. Two cuts are taken over the entire length of the piston, one for roughing and one for finishing. A forming tool on the front of the cross-slide faces the ends of the piston proper, and roughs out the grooves shown on the

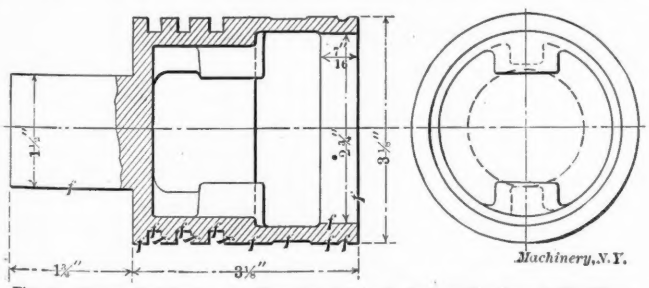


Fig. 2. Piston finished on a Cleveland 2-inch Automatic Screw Machine.

cylindrical surface. Then a forming tool on the rear of a cross-slide finishes the grooves in the ring; it has been found that one single roughing cut does not leave them quite smooth enough for the purpose for which they are intended.

In Fig. 1 part of the machine on which these operations are performed, is shown, together with the tools employed, and with the work in place. It will be noticed that the machine is provided with a tilting magazine attachment, into which the rough castings are fed, and from which the machine receives the castings automatically, as the work progresses. If the cast iron from which these pistons are made is not too hard, it has been found that it is not necessary to grind the tools employed any oftener than once every two days. It is of the greatest interest to note the extreme cheapness of cost of producing work in a machine of this kind. It is estimated that the operating expense for the machine is only one mill a minute, so that the piston shown, being finished as it is in eight minutes, is produced at an actual labor cost of only 8 mills, or 0.8 cent. Of course, this means that the operator runs a considerable number of machines, which he can easily do, inasmuch as the machine, when properly set, requires very little attention.

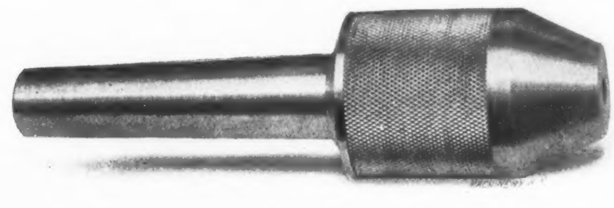


Fig. 3. Chuck shown in Detail in Fig. 4, finished in 40 1-2 minutes.

In Fig. 3 is shown another interesting article produced on a 4¼-inch Cleveland automatic screw machine, and which, as will be seen, is to be a drill chuck when completed. The parts of this drill chuck which are made in the screw machine, are shown in detail in Fig. 4. The work consists of four pieces: a shank or stem, a nut, a collar, and the chuck proper, all produced in the screw machine in 40½ minutes. These pieces are all made from machine steel and are therefore finished all over. While this work was performed on a

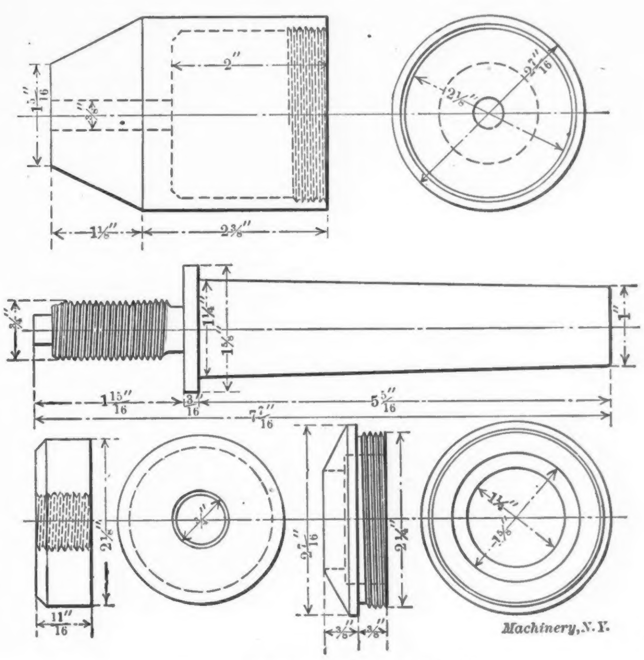


Fig. 4. Details of Chuck in Fig. 3.

4¼-inch machine, it would have been even better to employ a 3¼-inch screw machine, but in the present case the machine was to be employed for work of larger sizes as well, and therefore a large size machine was fitted up so as to be able to perform operations on smaller work also. It will be noted that the diameter of the stem is very small, considering the size of the machine, and it was required to arrange the machine so that it would give the correct speeds for small diameters as well as for large ones. Considering the time used in finishing the piston, as already stated, it will be seen that the actual labor cost is only 4 cents, and that if allowance is made for the time required for changing over from one class of work to another, after a number of pieces of one kind have been made, the total labor cost of the four parts would still be less than 5 cents.

One of the most interesting operations in connection with the making of the chuck shown is the making of the stem. This, of course, must be made with the threaded end headed

outward, which means that it is not possible to produce the tapered part with tools placed in the turret. The taper end, therefore, is produced with a forming tool in the cross-slide,

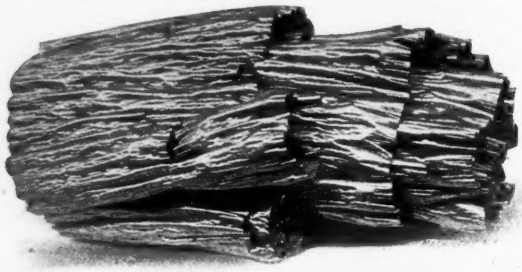
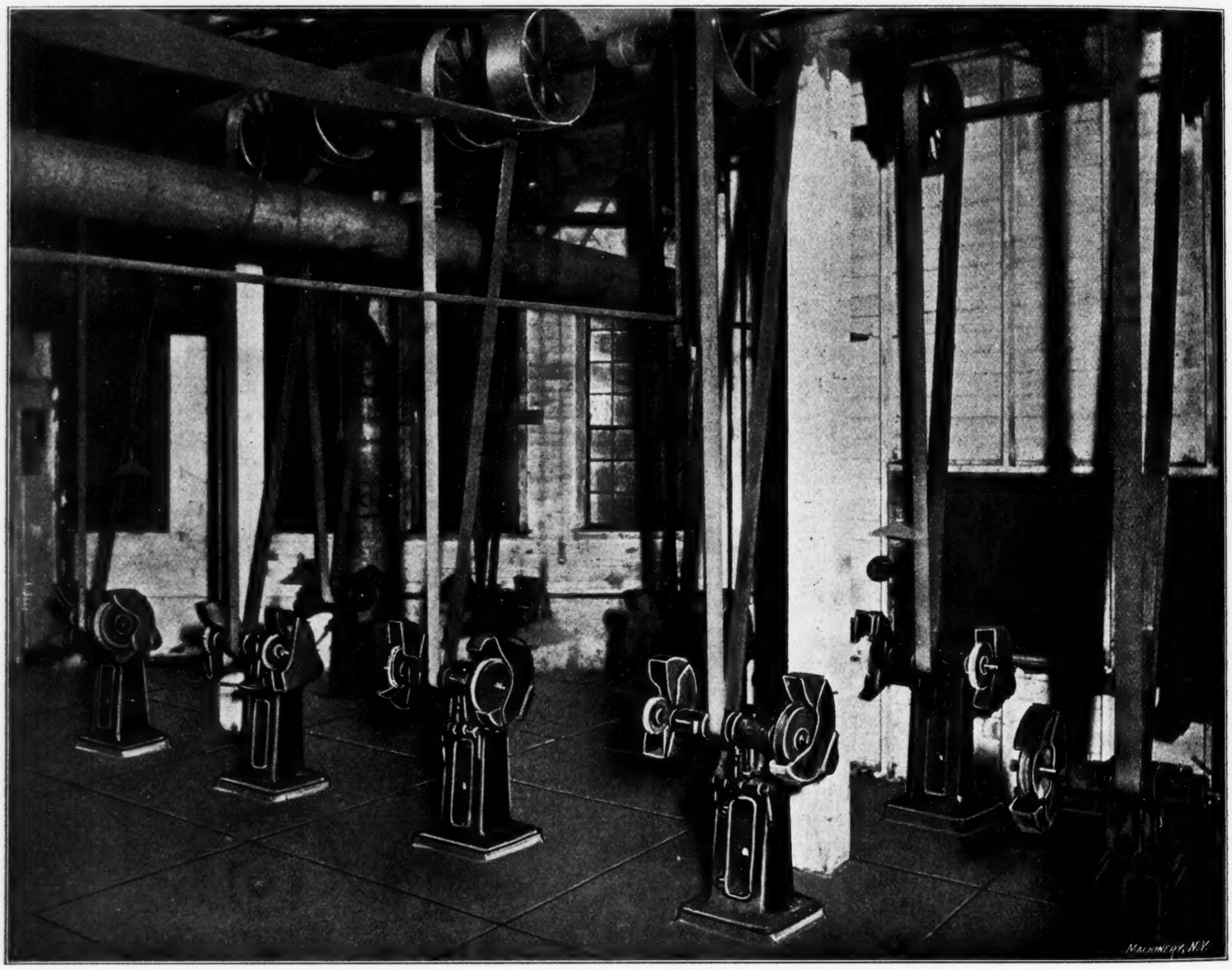


Fig. 5. Forming-tool Chips resulting from turning Shank of Chuck in Fig. 3.

taking a cut the full length of the shank, which is over 5 inches, the steady-rest supporting with rollers the end of the bar on the part on which the thread is to be cut.



The Polishing Room of the Fox Machine Co., which is equipped with an Exhaust System laid beneath the Floor.

Chips have been removed from the tapered shank, the full width of the piece, and 20 inches long, without breaking. In Fig. 5 a photograph of one of these chips is shown. The possibility of obtaining such long chips, without breaking, indicates that in spite of the width of the forming tool, the cut is very steady, as otherwise the chips would break off as soon as they were removed from the piece.

The illustrations shown give a general idea of the possibilities of the large size automatic screw machine. It is interesting to speculate upon how long it would take even an expert mechanic to turn up the different pieces shown in Fig. 4, in an engine lathe, boring and threading them as indicated, and finishing them with the same accuracy that an automatic screw machine is capable of. When this time is compared with the time taken by the screw machine for performing the same operations, we have a good example of the labor-saving qualities embodied in modern automatic machine tools.

THE POLISHING ROOM OF THE FOX MACHINE CO.

The polishing room of the Fox Machine Co. is notable for its neatness and convenient arrangement. As may be seen in Fig. 1, this is quite largely due to the fact that the polishing stands are equipped with an exhaust system which is laid beneath the floor of the room, so that the ceiling and floor are not encumbered by unsightly pipes. It will be noticed, also, that there are no counter-shafts, the design of the machine used (see department of "New Machinery and Tools" for this month) permitting the spindles to be started and stopped without the use of clutches or tight and loose pulleys.

There are, in this room, ten double-end Fox polishing machines in position, with space for ten more. They are arranged in two rows of five each, all facing the same direction. The polishing department is a one-story building connected to the machine shop on one side and the rough store department on the other, so that the natural flow of the material to be treated passes through it. The plating department is also connected with it on one side. The building has windows on three sides and is also lighted by four large skylights directly over the machines, providing an abundance of light. The building has a cement floor in which the proper provisions have been made for installing additional machines as they are required.

As stated, the exhaust system is laid beneath the floor of the room. The dust is drawn into the column of the machine and thence into an opening in the cement floor, through ducts leading to the main header, indicated at the top of the diagram in Fig. 2. The ducts are made of galvanized steel and are entirely surrounded with concrete, so that even though the steel should rust out, the duct will still be complete. These run directly under each line of machines. The main header tapers from 18 inches in diameter at the end, to 30 inches diameter at the outlet. It is provided with a manhole at one

end, and at the other it leads into the upright exhaust pipe seen in the background of Fig. 1, connecting with a 40-inch exhaust fan.

The power for driving this lot of ten machines is taken from a 15 horse-power motor. The line of shafting runs over each row of machines and is belted direct to them without the use of counter-shafts. The amount of power consumed is small, especially when it is considered that most of these machines employ two men at a time. The use of roller bearings in the machines and in the line shafting will account

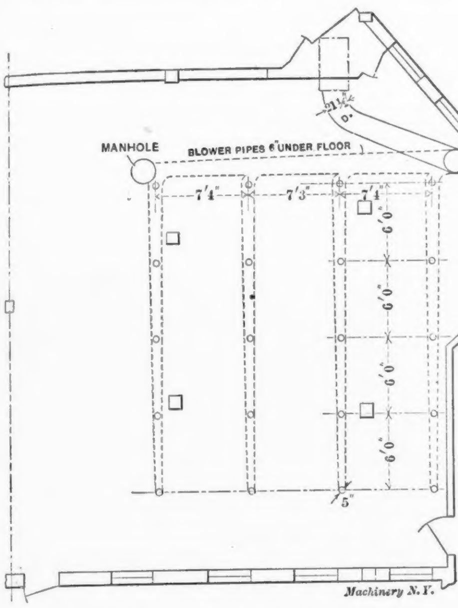


Fig. 2. Plan of the Fox Machine Co.'s Polishing Room.

largely for the small power consumption, which is sufficient for running all of the machines at their full capacity. This means not only a direct saving in the cost of the current, but also in the maintenance expense.

Polishing rooms such as this present a marked and agreeable contrast with the unsightly and unhealthy conditions which existed almost universally in such work ten or fifteen years ago, and which have not by any means been yet entirely done away with.

* * *

An electric light plant in Rue Saint Roch, Paris, was built with its foundation and the facade of heavy masonry continuous with the walls of an adjacent house, the division walls being separate. The vibrations of the engines and dynamos so affected the adjacent property that the tenants were unable to sleep nights, and it became imperative to separate the foundation of the power plant from the tenement building so as to reduce the tremors. The company's engineer, Mr. Friese, conceived the idea of sawing the building foundations and facade apart. This was done with thin wire rope and wet sand. An elaborate frame-work was erected upon the sidewalk, having pulleys and counter-balancing weights and a traveling electric motor. A well was dug to receive the water and sand, and a horizontal hole was bored at the top of each pier of the foundation. A continuous steel rope was threaded through these holes and then carried back over the building to the motor and machinery on the sidewalk. The operation was successful, the foundation being cut at the rate of three or four inches per hour. After the cut had been carried clear down to the bottom, a second cut was made two inches from the first, thus leaving an isolated section which was easy to break down and clear away. A rope lasted about twenty hours. The facade was cut away in the same manner without interruption of the power plant or damage to the buildings.

* * *

Roller back rests are successfully used in turret lathe practice. They offer a minimum resistance to rotation of the work and polish it, giving the surface a smoothness and density not possible to secure with a cutting tool. These rollers have to be made very carefully, having to be hardened and accurately ground on the exterior and in the bore.

MACHINE SHOP PRACTICE.*

BORING AND PLANING CORLISS ENGINE CYLINDERS.

M. B. STAUFFER.†

The Corliss engine cylinder is a difficult piece to cast correctly, and have it free from defects in regard to soundness, etc., and the inexperienced man will often have difficulty in securing satisfactory results. The writer was connected with a firm which subjected all cylinders to a hydraulic test before any machine work was done on them. The cylinders were not made in this firm's foundry, and when the first ones were received from the independent foundry, they were machined in the usual manner, but on the testing block they showed leaks. The firm not being desirous of patching them and sending out defective castings, had to reject them. After this experience the hydraulic test was made. To close the cylinder for testing, strong wooden heads can be made to bolt or clamp over the openings, suitable packing being used on the joints to make them tight.

On the Shop Operation Sheet accompanying this issue, the method of boring a Corliss engine cylinder is given. The various steps in this operation are there described as applied to a regular Corliss engine cylinder boring machine, which is, of course, best adapted to the work. Such a machine, however, may not be available, and, therefore, it will not be out of order to give another method of doing this work.

If a vertical boring mill, having sufficient vertical tool travel, is at hand, the cylinder may be bored on this type of machine. The casting is set on the table of the mill and is trued by the periphery of the flanges on each end. The end resting on the table of the machine can be set by the concentric circles on the table. Both ends must run true, and the cylinder must be securely clamped, because the tools are to work at a considerable distance from the table, which gives a great leverage against the clamps. All the work that can be performed on this end of the cylinder may now be done, including the boring, counter-boring, and facing of the flange. The cylinder is then inverted, and it may be centered on the table with a special centering plate which fits into the finished counter-bore and which has a projection fitting into the hole in the spindle, which sets the plate concentric with the table. The counter-boring on the opposite end may now be done and the flange faced.

The port faces or seats for the bonnets may also be trued up on the mill, but if a double or four-head planer is available, it will be found more economical to plane these faces, and also the steam and exhaust flanges. In planing the port faces, the cylinder must be so set on the platen that its center will be level or parallel with it. If the casting is true to the pattern, it may rest on the rough port faces, though, of course, it will be necessary to test the other parts before it is machined, so as to make sure that there is sufficient stock to finish to all required dimensions. If the planer is provided with side heads, the flanges for the steam and exhaust pipes may be faced at the same time that the port faces are being planed.

The next operation to be performed is boring the valve ports. The finish lines for the holes may now be laid out with reference to the center line and crank end of the cylinder. In this case it will be necessary to lay out lines on each end of the ports. The holes which are to be drilled for the bonnets and the back caps should also be laid out. These holes should be drilled and tapped; then the ports are ready to be bored. A boring outfit which is commonly used, consists of a suitable bar for carrying and guiding the cutter; a lead-screw for feeding the bar, which extends to the end of the bar and usually has a star feed arrangement to actuate it; and two bonnets, with adjustable brass bushings, to act as bearings for the bar. These bonnets are fastened on the ends of the ports by studs inserted in the holes which were previously drilled and tapped. The stud holes in the bonnets are extra large to allow for the necessary adjustment. After the bar has been accurately centered with the lines previously laid out, the bonnets are securely fastened in place, and the

* With Shop Operation Sheet Supplement.
† Address: Scottdale, Pa.

first cut started. The tool should have a square cutting face as the bar must necessarily be light and if the cutting edges of the tool are beveled to any appreciable extent, the bar will be deflected by the pressure of the cut. It is, however, essential that the corners of the cutting tool be slightly rounded, or they will soon be worn away. When the hole has been rough-bored, it should be carefully examined to see that the edges of the steam ports are perfectly sound and trued up properly. This can be done by having a light held at one end of the hole while inspecting the work from the opposite end. If the construction of the boring-bar is such as to permit its removal without disturbing the setting, this should be done and the edges of the port slightly beveled with a file inserted in an extra long handle. This is desirable because it prevents the finishing cutters from coming in contact with any scale. The port may now be finish-bored, and if the bar is well constructed and the work carefully done the ports will not require subsequent fitting or scraping. After all the ports are finished, the cylinder may be drilled for the frame, head, and wrist plate stud if the cylinder is of the wrist-plate type. The drilling and tapping for the indicator pipes should also be done, after which the cylinder may be sent to the erecting floor for fitting and testing.

* * *

HOW A BIG BOILER STACK WAS ERECTED.

The improvements to the plant of the Crocker-Wheeler Company, of Ampere, New Jersey, manufacturers of electrical machinery, have reached the stage where work is being started on the new power house, which, when completed, will

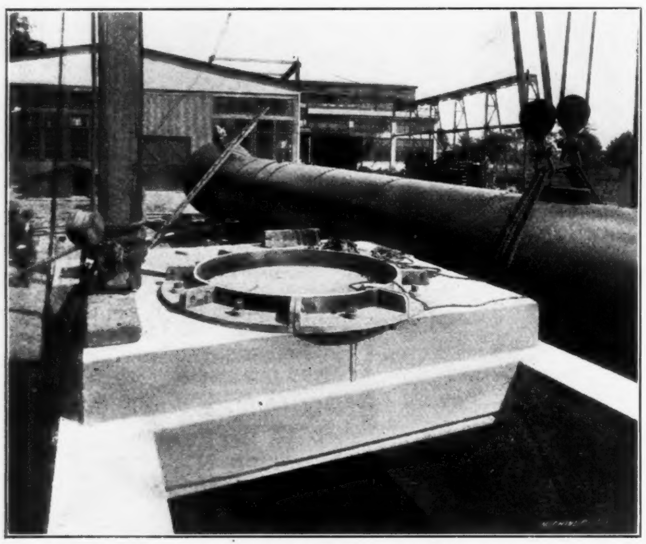


Fig. 1. Steel Stack 72 Inches in Diameter and 105 Feet Long, which was hoisted into Position in One Piece.

have a capacity of 4,800 boiler horse-power. This entire capacity will not be installed at once, and to furnish draft for the boilers temporarily, until the complete plant is installed, the company has just erected a steel stack, 72 inches in diameter and 105 feet high, having a total height of 125 feet when on the foundation.

The engraving, Fig. 1, shows the stack lying alongside the concrete foundation; Fig. 2 illustrates the method of lifting, while Fig. 3 shows it in place. As will be seen, two large gin-poles were first erected, one on either side of the foundation, and supportd by steel stays leading from their tops to various anchorages. To the top of each pole powerful tackle was attached which was connected to a hoisting engine. The stack was first lifted in a horizontal position onto its foundation, after which the gin pole on the side of the foundation formerly occupied by the stack, was moved in as close as possible, so as to obtain a more nearly vertical pull on the poles. The tackle was then attached to the stack at a point slightly above the center of gravity and it was slowly lifted high enough to permit the bottom to clear the foundation. To facilitate the hoisting and at the same time prevent the bottom of the stack from being injured, it was supported upon a platform mounted on rollers as shown in Fig. 2.

This stack will supply natural draft to 800 H.P. water tube boilers (burning No. 2 buckwheat coal) with an ultimate capacity under artificial draft of 1,600 H.P. The boilers are of the modern high-pressure water tube type for generating steam at 200 pounds pressure. The furnaces of the boilers are each 9 feet 8 inches wide by 10 feet deep. The breeching connection between the stack and the boilers is 6 feet wide

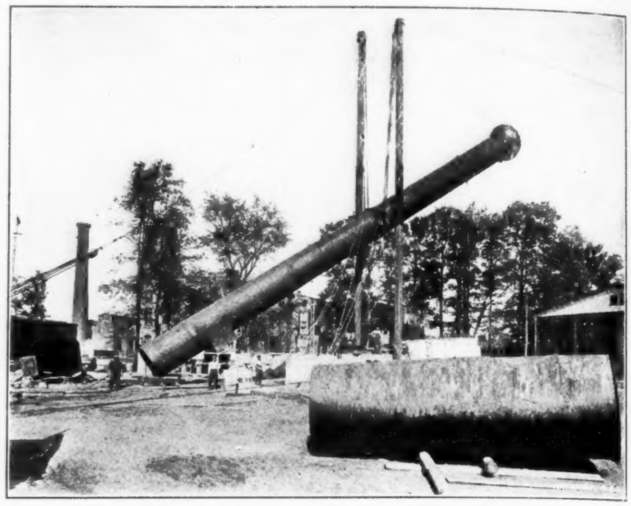


Fig. 2. View showing the Method of lifting the Stack.

and increases in height as it reaches the stack to provide for future installation of boilers. The breeching is built of the arched top and bottom plate construction to make it self supporting. The weight of the stack and breeching is approximately 18 to 20 tons, and the stack was hoisted into position in one piece, which attests to the progress of engineering construction, as this would have been impossible a few years ago. The present stack is to be used temporarily until further development of the plant, at which time it is contemplated to erect permanent brick chimneys. For that reason it is located at present in position to provide for future development until the last boiler installation is made, and is erected on one of the future boiler setting foundations. The

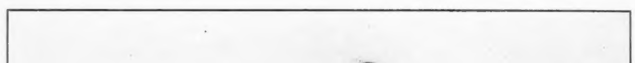


Fig. 3. The Stack after Erection.

connection to the foundation is provided by means of a cast iron sectional annular ring which is bolted to the foundation and also to the stack. The stack was designed and erected by the engineering construction office of Mr. Walter Kidde, New York City, and was built by the Dover Boiler Works, Dover, N. J.

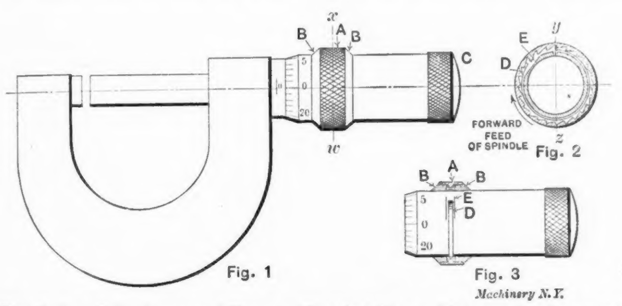
LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

MICROMETER RATCHET STOP.

The accompanying illustration shows an improved form of ratchet stop or sensitive feed which I am using on my micrometer. It is more conveniently located than the ordinary form at the end of the spindle, so that it can be operated by the fingers of the hand that holds the micrometer, leaving the other free to hold the work being measured. This cannot be done with the ordinary stop, and, consequently, as careful inquiry has shown, a very small percentage of micrometer users ever make any use of this feature, an extremely desirable one, particularly in these days when the micrometer is no longer confined to the tool-maker, but is being introduced so largely into the machine shop and into the hands of less skilled workers. With many of these, unless the ratchet stop is used, the micrometer is very likely to be unduly strained, and the measurement taken will be incorrect; this will not occur with the form here shown, since as the micrometer is usually held in the right hand, the thumb and finger will naturally grasp the knurled operating ring *A*, Fig. 1.

Fig. 2 shows a section of the sleeve or thimble *C*, and ring *A*, on line *x-w*, with the spring or spring pawl *D* between them; and Fig. 3 is a section, on line *y-z*, of ring *A* and the retaining collars *B*, which latter are made a light force fit on the thimble. As will be seen in Fig. 2, one end of spring *D* is bent inward and held in a hole drilled in the thimble. The other end of the spring, which, as will be noted, nearly



Figs. 1, 2 and 3. Improved Form of Ratchet Stop which can be Operated by the Fingers of the Hand holding the Micrometer.

encircles the thimble, is bent outward and engages the teeth cut on the internal rib of operating ring *A*. In use, when the spindle is fed down on the work, continued turning of *A* causes the teeth to depress the free end of *D* into the recess *E* cut in the thimble, thus allowing the latter to remain stationary; reversal of the motion of *A* obviously causes positive engagement between ring and thimble, through spring pawl *D*, and consequent withdrawal of the spindle. An additional feature of value is that this form can be applied equally as well to the other forms of the micrometer, depth gages, etc., for which no ratchet stop has hitherto been available. Its satisfactory working in daily use for several years is sufficient proof that it is a good thing. I may add that the improvement is patented. C. W. PITMAN.

Philadelphia, Pa.

PROGRESSIVE PUNCH AND DIE.

In the engraving (Fig. 2) is shown a punch and die for making a complete piece such as shown unblanked at *A* in Fig. 1, at every stroke of the press. The strip is put into the

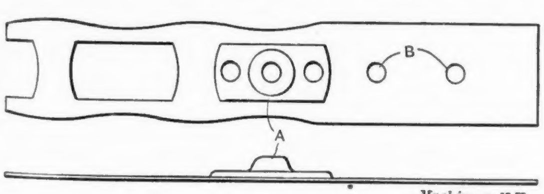


Fig. 1. Appearance of the Stock from which Plates A are Blanked

die up to the first former, and at the first trip of the press two holes *B*, are pierced. These holes are then placed over the countersink punches *C* in the former and, at the second tripping of the press the plate is formed and the center hole pierced by punch *D*, and a second pair of holes pierced. The strip is again shifted, bringing the second pair of holes over the countersink punches and the formed part in the strip over the blanking die *E*. At the next stroke the formed part is

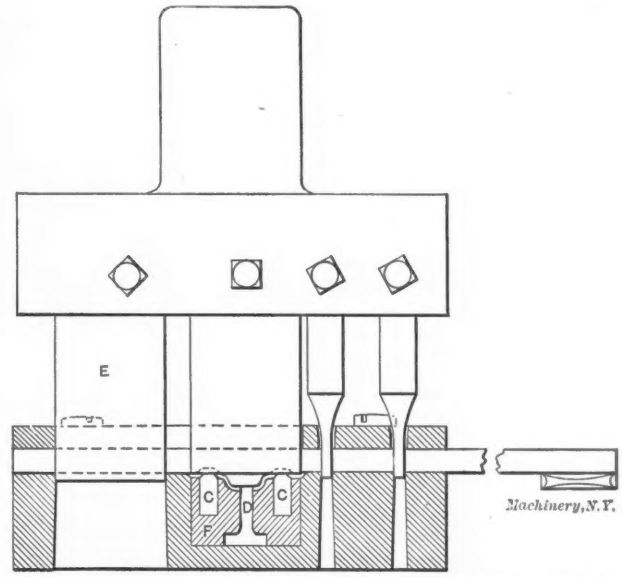


Fig. 2. Progressive Punch and Die for Forming Plates shown at A in Fig. 1.

blanked out, and at the same time a new part is formed and other holes pierced; this is continued until the strip is run through.

In laying out these dies, care must be taken to have the distances between the center lines to correspond, as otherwise the work will not come through the die perfect. There will also be the danger of breaking the countersinking forming punches, owing to the strain due to the irregularities in laying out. The die is so constructed that the former *F* can be removed when grinding. After the die is ground, the difference between its height and the original height is ground off the bottom of the former. GEORGE CULLEY.

Springfield, O.

SIMPLE BUT EFFICIENT MILLING FIXTURE.

The accompanying illustrations show a piece of work, and the method employed for finishing the bosses on same by milling. In Fig. 1, which shows the work, the surfaces fin-

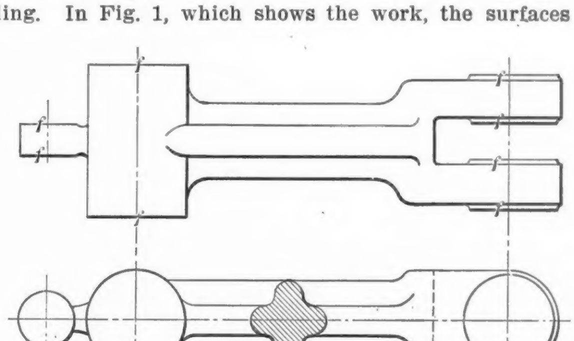
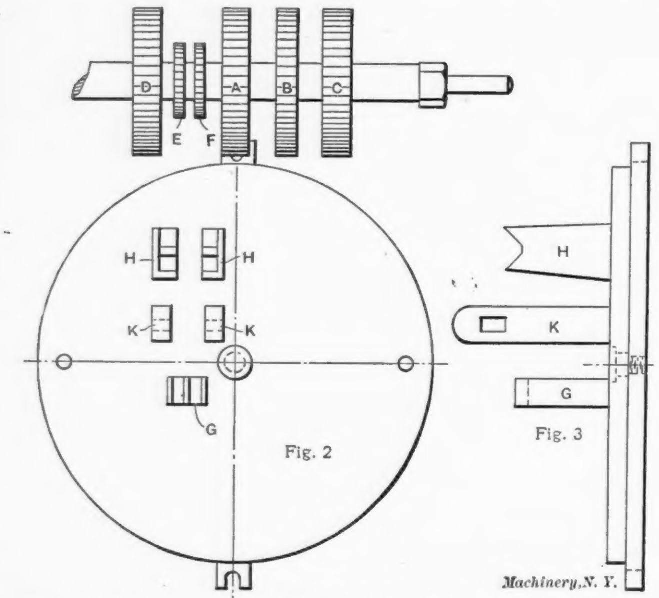


Fig. 1. The Work to be Milled.

ished are indicated by the letter *f*. The fork end of the work is finished by the cutters *A*, *B*, and *C*, Fig. 2, while the other end is finished by the cutters *D*, *E*, *F*, and *A*, in the same figure. In Fig. 2 is also shown a plan view of the device which supports the work when being milled, Fig. 3 being a side view of the device. It will be seen that the fixture for holding the work is very simple, consisting simply of three V-block supports, one at *G* supporting the casting near the fork end, and two at *H* supporting the hub at the other end. There are two vertical standards *K* which are mortised for a key which clamps the work down on the V-blocks. The par-

ticular feature of this device is that the V-blocks are located at such a distance from the center that, when the hub is milled and finished, and the upper plate of the jig revolved one-half of a revolution, the center cutter *A*, which has been previously employed for finishing one side of the hub, will be in correct position to mill one side of the fork end, the spacing collars between the cutters, of course, being made to take care of the required distance. The stop pin is used for keeping the upper revolving plate in the correct position in regard to the lower bed-plate.

A milling fixture of this description can be used advantageously on a great number of pieces which are ordinarily



Figs. 2 and 3. Fixture for Milling Work shown in Fig. 1, at One Setting.

jigged two or three times. One great advantage inherent in this class of fixture is that the work is finished at one setting, thus insuring that all the machined surfaces are in proper alignment. Another advantage is that the work is handled only once at the milling machine, while if milled in the usual way, the hub end would be milled with a straddle mill, and then the casting taken to the drill press, and after the drilling operation returned to the milling machine for finishing the fork end, the work being probably held on another milling jig, and located by a pin or stud through the hole in the hub. Y. ZIEGLER.

SELECTING A CYLINDER OIL.

In selecting an oil for cylinder lubrication, oil which is entirely free from any vegetable or animal fat should always be chosen; that is, only a pure mineral oil should be used for this purpose. Vegetable oils oxidize at comparatively low temperatures, becoming thick and gummy, and have no lubricating properties whatever. Animal oils also act in a similar manner when subjected to heat. Animal and vegetable oils are often mixed with mineral oil in order to form a cylinder oil having a high viscosity and fire test. Suspected compounds of this kind may be tested by adding a little soda ash or caustic soda, and shaking it up in a bottle. If it clouds up and looks soapy, it indicates the presence of animal oil. Such a compound should never be accepted at any price.

Paraffine is frequently added to cylinder oil, but this is also highly objectionable. Its presence may be detected by placing a bottle of the oil on ice for fifteen or twenty minutes. If it becomes cloudy, it shows the presence of paraffine, and should be discarded at once.

Engine oils having an opalescent green tinge when held up to the sunlight, instead of appearing clear red or yellow, contain either kerosene or some lighter hydro-carbon, which is not a lubricant, and which volatilizes as soon as it becomes heated. Oils showing this characteristic should be avoided. Ordinary lubricating oil for high-speed engines should have a viscosity ranging from 170 to 195 at an average temperature of 75 degrees. Its specific gravity should be between 29 and 31, and the flash test between 400 and 440 degrees.

When the steam pressure carried is less than 100 pounds per square inch, cylinder oil should have a fire test between 590 and 630 degrees. For pressures ranging from 100 to 200 pounds per square inch, the fire test may range from 600 to 660 degrees. The specific gravity of a cylinder oil having a fire test of 600 degrees should be from 26 to 27, and for 660 degrees, from 24 to 25. Sometimes when there is considerable moisture in the cylinders, it is desirable to use a small amount of animal oil in the lubricant. In this case refined and acidless tallow oil should always be used. Common lump tallow should never be employed for this purpose, as it contains an acid which corrodes the cylinder walls and also leaves charred particles in the steam. The amount of tallow oil to be mixed with mineral oil may be taken as follows: For steam pressures below 100 pounds per square inch, 8 to 10 per cent of tallow oil; and for pressures from 100 to 200 pounds, from 3 to 6 per cent. Cheap grades of cylinder oil are often adulterated with wool fat, which is used to cut the gummy ingredient and give the oil a good flow in a cold test. Wool fat causes the oil to separate and form a thick deposit at the bottom of the barrels. Oil containing this adulteration leaves charred particles in the steam the same as lump tallow. CHARLES L. HUBBARD.

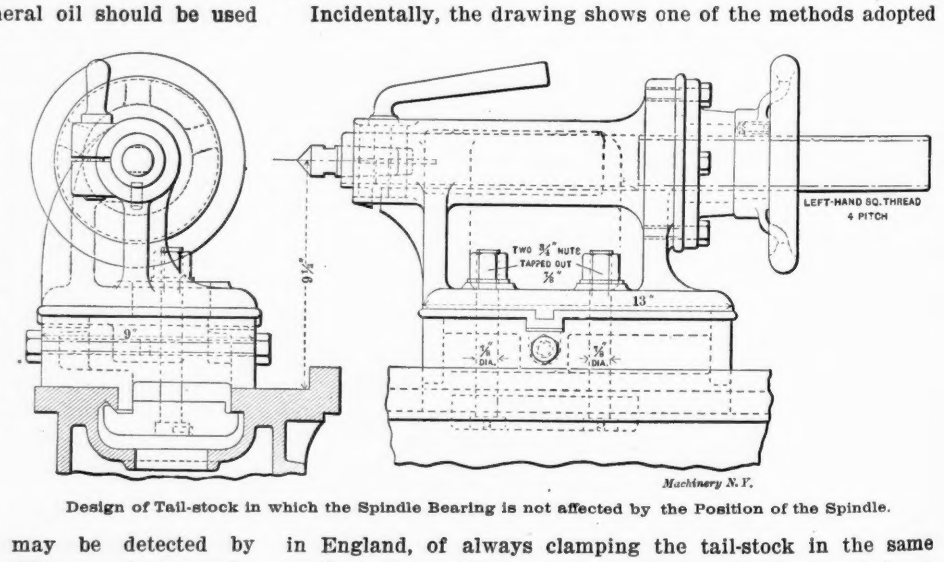
Auburndale, Mass.

A TAIL-STOCK DESIGN.

The engraving illustrates a new type (or rather an old type revived) of tail-stock, which has become popular in Europe, and in my opinion its superiority over the ordinary style is great enough to warrant its universal adoption. The bad feature of the ordinary tail-stock is that when the spindle is moved out, the bearing in the barrel becomes shorter, whereas to be right it should be longer.

This improved style, though it does not give more bearing the farther the spindle projects out, does the next best thing; it gives a uniform bearing whether the spindle projects more or less. The spindle is, of course, perfectly parallel, and is provided with either a square or Acme thread at the rear end. It will be seen that the screw (as a separate part) is dispensed with, and it isn't necessary to bore out the spindle to receive the screw, so that besides being more correct in principle, this design is cheaper to construct than the ordinary one.

Incidentally, the drawing shows one of the methods adopted



Design of Tail-stock in which the Spindle Bearing is not affected by the Position of the Spindle.

in England, of always clamping the tail-stock in the same vertical plane. Of course, in America, with the inverted vee bed, this takes care of itself, but when a flat top bed is used, some means must be provided to ensure a proper location of the tail-center, otherwise taper work will result. I believe

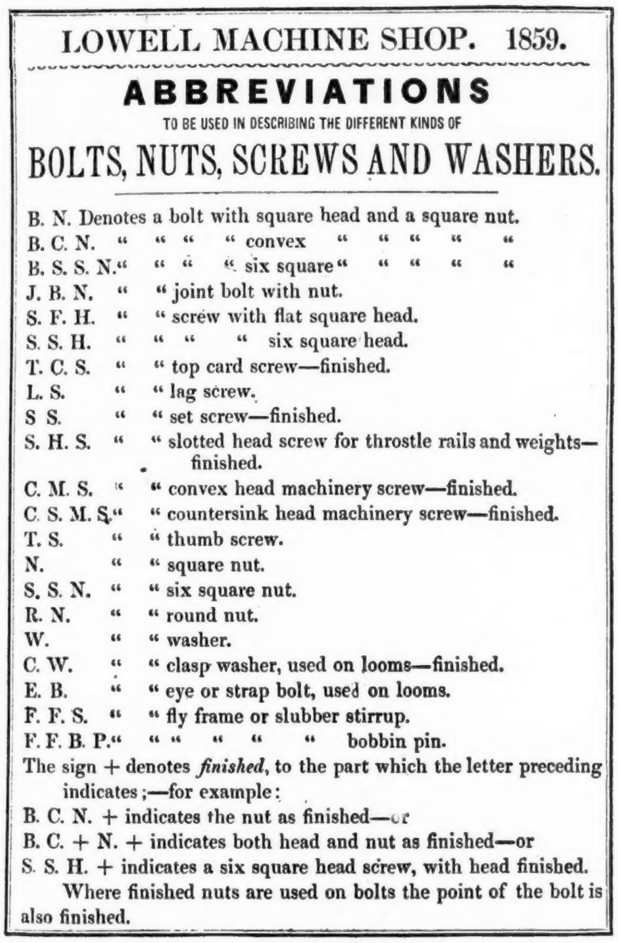
that a method similar to this is used by William Sellers & Co. to overcome this difficulty.

Another point, which, though insignificant in itself, is worth drawing attention to, is that the tail-stock clamping bolts are each ⅞ inch in diameter, with only ¾-inch nuts; this was done so that the wrench which tightens the tool strap bolts could also be used for the tail-stock bolts. As mentioned before, this is only a detail, but it is one that should receive more attention from machine tool designers, so that a machine will not have a set of wrenches which takes up as much room as itself. RACQUET.

[Our common form of engine lathe tail-stock is a good example of the sacrifice of utility in machine design to mere prettiness. The above design, which aside from minor details is essentially the same as that generally used by early lathe builders here and abroad, is much superior to the modern type, in rigidity and wearing qualities, no doubt. Its drawback is ugliness, and that seems to have been sufficient to discredit it in America notwithstanding its manifest superiority.—EDITOR.]

ABBREVIATIONS FOR BOLTS, NUTS, ETC.

The accompanying engraving shows an old list of abbreviations which is still used in ordering bolts from the bolt shop of the Lowell Machine Shop, builders of textile machinery. It is rather ancient history, but could hardly be improved



LOWELL MACHINE SHOP. 1859.

ABBREVIATIONS

TO BE USED IN DESCRIBING THE DIFFERENT KINDS OF

BOLTS, NUTS, SCREWS AND WASHERS.

B. N. Denotes a bolt with square head and a square nut.
B. C. N. " " " " convex " " " " "
B. S. S. N." " " " six square " " " " "
J. B. N. " " joint bolt with nut.
S. F. H. " " screw with flat square head.
S. S. H. " " " " six square head.
T. C. S. " " top card screw—finished.
L. S. " " lag screw.
S S. " " set screw—finished.
S. H. S. " " slotted head screw for throstle rails and weights—finished.
C. M. S. " " convex head machinery screw—finished.
C. S. M. S." " countersink head machinery screw—finished.
T. S. " " thumb screw.
N. " " square nut.
S. S. N. " " six square nut.
R. N. " " round nut.
W. " " washer.
C. W. " " clasp washer, used on looms—finished.
E. B. " " eye or strap bolt, used on looms.
F. F. S. " " fly frame or slubber stirrup.
F. F. B. P." " " " " " bobbin pin.

The sign + denotes *finished*, to the part which the letter preceding indicates;—for example:

B. C. N. + indicates the nut as finished—or
B. C. + N. + indicates both head and nut as finished—or
S. S. H. + indicates a six square head screw, with head finished.

Where finished nuts are used on bolts the point of the bolt is also finished.

List of Abbreviations for Different Kinds of Bolts, Nuts, Screws and Washers.

on for brevity and clearness. Something of this sort is necessary on account of the large number of bolts used by the company, amounting to some 30,000 per week during the busy season of last year. PAUL W. ABBOTT.

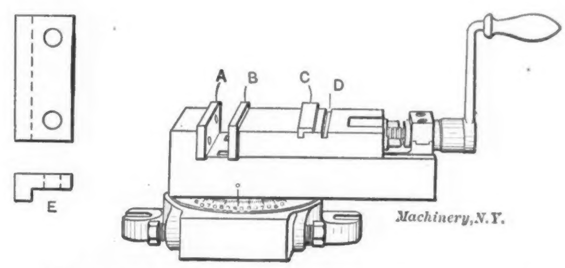
Lowell, Mass.

OBJECTION TO USING COPPER WIRE WHEN CASE-HARDENING.

Small soft steel or wrought iron parts should never be strung on a copper wire when case-hardening. The following incident will explain the reason why. A large number of small gears were to be case-hardened by the common process of enclosing them in an iron box filled with granulated bone, etc., and the person in charge thought it advisable to string the small gears on a wire, in order to prevent losing any of them. Not realizing that the fusing heat of copper is some 500 or more degrees less than that of steel, he picked up some copper wire and carefully strung all the small gears on this. The result was that when the box was put in the furnace, the copper wire melted and ran into the teeth and over the surface of the gears, so that it was necessary to put in two or three days of filing and scraping to remove the copper. Since the above incident happened, soft steel wire is always within handy distance of the hardening man when required for the purpose mentioned above. R. S. F.

AN ATTACHMENT FOR BROWN & SHARPE MILLING MACHINE VISES.

Referring to the illustration, *A* is the regular positive jaw of a milling machine vise, *B* the regular adjustable jaw, and *C* an attachment or false jaw to increase the capacity of the vise by using it instead of the jaw *B*, which is removed. In our shop we had occasion to hold work 3 inches wide, and



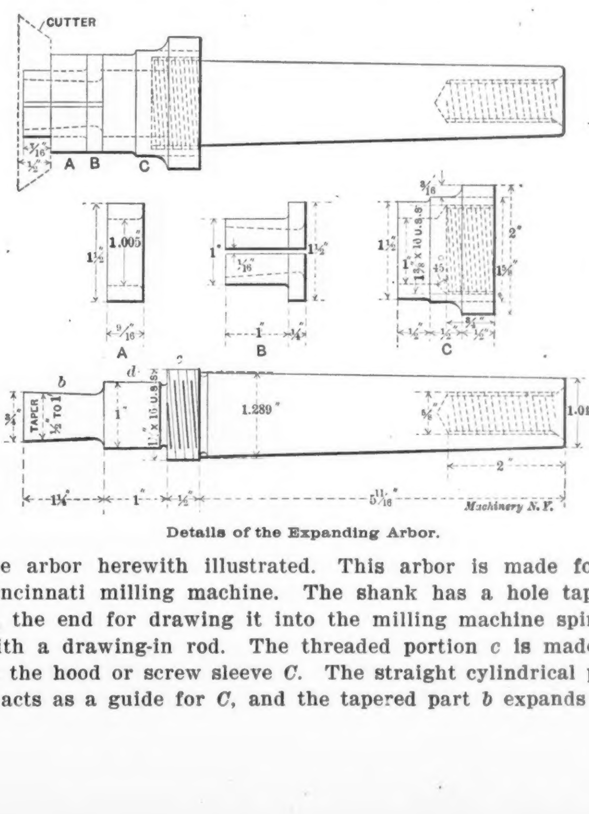
Milling Machine Swivel Vise equipped with Attachment for Increasing its Capacity.

the vise would only open 2¾ inches, so the above attachment, which we find very handy, was made, as it about doubles the capacity of the vise, especially on large flat work. An extra slot can be cut in the vise-back, as at *D*, and the false jaw can be used at either place. The jaw is shown in detail at *E*. It is held on by two filister head screws, and can be used on either the swivel vise, flanged vise, or on the tool-maker's universal vise. J. T. GEORGE.

Attleboro, Mass.

IMPROVED EXPANDING MILLING MACHINE ARBOR.

Having had considerable dove-tailing and end milling close to shoulders and walls of casting, and being caused much trouble with the old style split expanding arbors with the taper plugs and screws in the ends, I designed and made



Details of the Expanding Arbor.

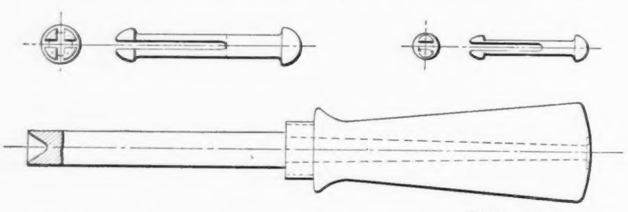
the arbor herewith illustrated. This arbor is made for a Cincinnati milling machine. The shank has a hole tapped in the end for drawing it into the milling machine spindle with a drawing-in rod. The threaded portion *c* is made to fit the hood or screw sleeve *C*. The straight cylindrical part *d* acts as a guide for *C*, and the tapered part *b* expands the

split sleeve *B*, which holds the milling cutter. This sleeve *B* is finished in one piece and a 1/16-inch radial slot is cut in from opposite sides to within about 1/16 inch of the bore. It is then hardened and ground all over on a tapered mandrel. The mandrel is then driven into the sleeve until it is parted, and the rough edges which are left are ground off on the side of the emery wheel. The taper of the split sleeve and the corresponding taper of the mandrel should be ground at one setting of the taper attachment, so they will coincide. The mandrel should be ground first, then sleeve *B*, until the large end of the tapered part *b* of the mandrel just enters the large part of the bore in the sleeve. It will be noticed that the hole in the collar or washer *A* is made a little larger in diameter than the part on the sleeve *B* over which it fits. This is done so that *A* will not interfere in the expanding of *B*. In assembling the arbor, the sleeve *C* is first screwed on, then the two halves of *B* are placed on the tapered part and the collar *A* passed over them to hold them in place. The diameter of the expanding sleeve *B* and the thickness of the collar or washer *A* should be made in proportion to the diameters of the holes and the thicknesses of the various cutters to be used. A spanner wrench is used on the sleeve *C* for drawing the arbor from the milling machine spindle and also for expanding *B* in the cutter to be used. It is evident that with this arbor a considerable pressure is obtained in the cutter, and a heavy cut can be taken. If the cutter slips, however, a slot may be cut across the end of the arbor, and a key long enough to project through the split bushing *B* and into a key-way in the cutter, inserted. This arbor has been in use for over a year on various jobs, such as dovetailing and general work, and it has paid for itself a number of times.

Lowell, Mass. FRANK G. STERLING.

SUBSTITUTE FOR COTTER PINS.

Referring to your article, "Substitute for Cotter Pins," published in the April issue, I beg to say that the pins there shown are not exactly like those which are used by Bofors-Gullspang Company, Sweden. These pins, which are shown in the illustration, are especially designed to connect certain



Substitute for the Ordinary Form of Cotter Pin, and Tool for Removing.

parts in breech locks instead of using screws and nuts. They can easily be removed and there is one part instead of two or three as when a screw is used.

The smaller sizes can easily be removed with the fingers and also some of the larger ones. In order to more conveniently remove the larger pins, a special tool is made as shown in the engraving. JOHN INGBERG.

North Tarrytown, N. Y.

MAKING PISTON RINGS.

The making of piston rings is neither so small nor such an inexpensive item in the manufacture of gasoline engines, as it would seem to a casual observer. In the design of the ring itself, there are two main types: the concentric cast iron ring, and the eccentric cast iron ring. Of these two, the latter type is probably more used, at least by the more progressive gas engine builders. Again, in the splitting or cutting the ends of the rings there are two prevailing methods: one method being to cut the ends so that they are "jogged" like stair steps, the other being a plain diagonal cut. The last method is preferred by the majority of builders on account of the ease in making.

In the machining of the ring, before it reaches the splitting stage, we need but glance over the pages of almost any mechanical journal to find dozens of tools, jigs, and various contrivances for holding the casting, boring the inside, and turning the outside, to say nothing of the tools, single and in gangs, used to cut off the rings from the finished blank. In the boring tools, especially, has "genius" been busy trying to devise tools that will quickly and thoroughly remove the most valuable part of the ring. One firm that I know of, and I don't know how many more, bores out its rings and then peens the inside to make them stiff! Why so few firms have failed to notice and profit by the example of the largest gasoline engine factory in the United States, has long been a puzzle to me. This firm uses

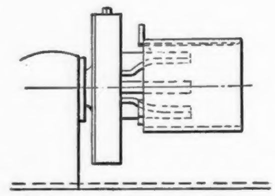


Fig. 1. Long-jawed Universal Chuck used for Facing Ends of Ring Blank.

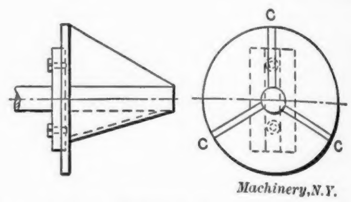


Fig. 2. Winged Center held in the Turret and used to set the Blank on the Face-plate.

an eccentric ring and doesn't bore it out at all. In this way the ring is stiff just where it should be. The plain diagonal split is also used, it not only being the easiest to cut, but just as good as any other style. Why anyone should go on boring out rings when a moment's thought shows the advantages of not doing so, is beyond me. This way of making rings requires a little more care in the foundry, but this is nothing compared to the saving in the machine shop, not to mention the increased value of the ring itself. In making the castings, they are provided with the usual three lugs, and the inside is made the size that the rings would be bored to

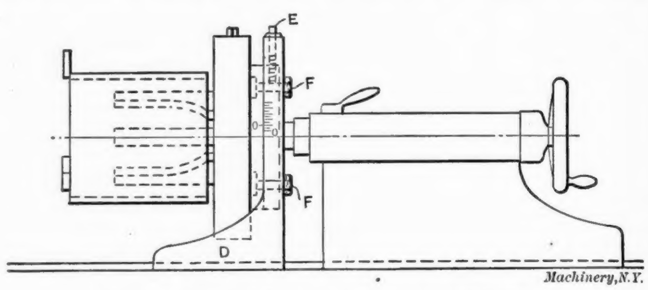


Fig. 3. Improved Device for Setting the Ring Blank.

were they made that way. Extreme accuracy is not needed, for the piston grooves are always made deep enough to allow for slight variation.

In machining these rings, without boring, the first rig that I remember seeing was the one shown in Fig. 1. It was simply a three-jawed universal chuck, with extra long jaws fitted to it, as shown. The casting was placed on these, and the lugs faced off. The other end was slightly countersunk. This work being done, the casting was taken to a machine having a fixture in the turret such as shown in Fig. 2. This fixture was set the proper amount above the center

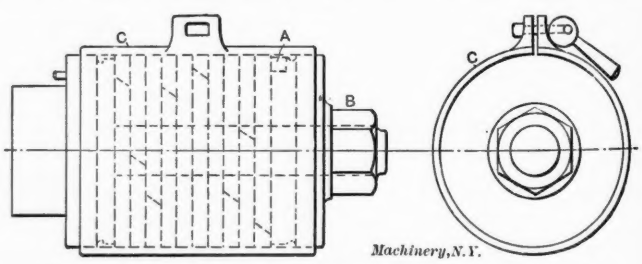


Fig. 4. Fixture for Holding the Rings while finishing the Outside.

to give the ring the required eccentricity. The casting was placed with the lugs toward the face-plate, and the turret, holding the fixture, run up so that the three rings came in contact with the slightly countersunk edge and held the casting against the face-plate. The turret was locked, and the lugs clamped to the face-plate. The turret was then run back, the casting turned and the rings cut off. This method, however, finally gave way to another, and the fixture shown in Fig. 3 was adopted. Less time was required, and all the work done on one machine. The body *D* of the fixture is of cast iron and is made to fit the ways of the lathe. A taper plug

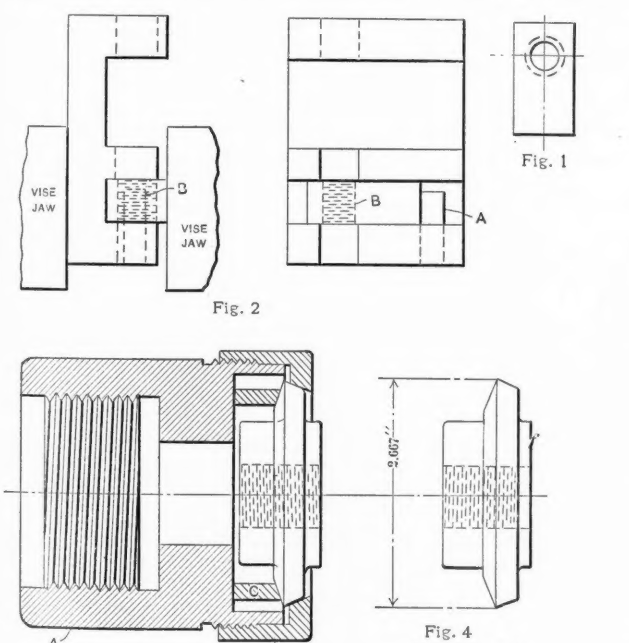
also connects it to the tail-stock spindle. The casting is held by a chuck similar to the one shown in Fig. 1. The amount of eccentricity given the rings is regulated by loosening the nuts *F* and turning the screw *E*, graduations which are provided, doing away with guess work. When the casting is placed on the jaws, as shown, the tail-stock and fixture is pushed forward until the lugs are a half inch or so from the face-plate. The tail-stock is then locked, and the fixture run up by using the hand-wheel. Paper is packed under the lugs where needed and they are strapped fast. The tail-stock and fixture is then run back out of the way, and the rings turned and cut off. After the rings have been ground on the sides and split in the milling machine, they are placed in the fixture shown in Fig. 4, and finished to the exact outside diameter. As will be readily seen, this fixture is of the ordinary type, the principal difference being the insertion of the hard steel block *A* used to set the tool to save calipering. After the nut *B* is tightened and the sleeve *C* removed, the point of the tool is run up against this block and the rings finished at one cut.

Another useless idea in connection with packing rings is that of putting a pin in the groove of the piston to keep the ring from turning. This is a relic of the old days, when cylinders had openings in them into which the ends of the rings were liable to spring and cause damage, and the pin was not originally intended to "stagger" the splits and thus prevent (?) the escape of gas, as many seem to think they were, or do.

Decatur, Ill. ETHAN VIALL.

DEVICES FOR HOLDING WORK WHILE TAPPING.

A simple and effective device for holding work while tapping often saves a great deal of time in the shop. In Fig. 1 is shown a piece of cold rolled steel $\frac{1}{4} \times \frac{3}{8}$ inch, which is to be tapped as indicated. Fig. 2 shows the device which is used to act as a guide for the tap. The piece is inserted in the slot at *B*, and pressed up against the locating pin *A*, and then the piece with its guiding device is clamped between the jaws in a vise, as indicated to the left. This insures a straight tapped hole, and at the same time, if many pieces are



Devices for Holding Work while Tapping.

to be made, the time saved is about fifty per cent. In Fig. 4 is shown a cast iron bevel gear which is to be faced and tapped as indicated. In Fig. 3 is shown the fixture used for holding this gear while facing and tapping. A holder *A* screws onto a spindle of a lathe, and the cap *B* holds the gear in position against the floating ring *C*. The cap locates the gear centrally and the floating ring takes the thrust and adjusts itself to the irregularities of the gear rim.

Alliance, O. E. D. GAGNIER.

NOVEL COMBINATION DIE.

In designing the combination die to produce the clip shown in Fig. 1, many things had to be taken into consideration. The clip had to be produced rapidly and cheaply, and therefore had to be done in a die that would produce a finished clip every stroke. The die had also to be arranged so that the brass strip could be fed in with the automatic feed. There were obviously two ways of feeding this clip: sideways, using 9/16-inch brass strip, and frontways, using 2 3/32-inch brass strip. The latter method was adopted because it would allow longer running of the press for each brass roll, as a 9/16-inch cross feed would only be required, against the 2 3/32-inch feed the other way; this method also made the die more compact, and brought the punches closer together. For cutting off, a shear punch was decided upon, thus totally avoiding any scrap except the four 3/32-inch punchings, which could not be avoided. As the stock was 22 B.W.G. it was not considered necessary to have a movable guide, but 5/16 inch was cut out at the side of the feed guide to allow the strip to bend down while the blank was sheared off. The shear *A* (Fig. 2) and the punches *B* were set at the same height so that punching and shearing would take place simultaneously. As the stroke of the press was not long enough to allow the forming punch *C* to push the clip right through the die, this punch

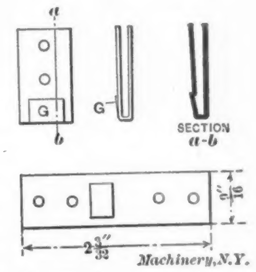


Fig. 1. Clip formed by the Combination Die shown in Fig. 2.

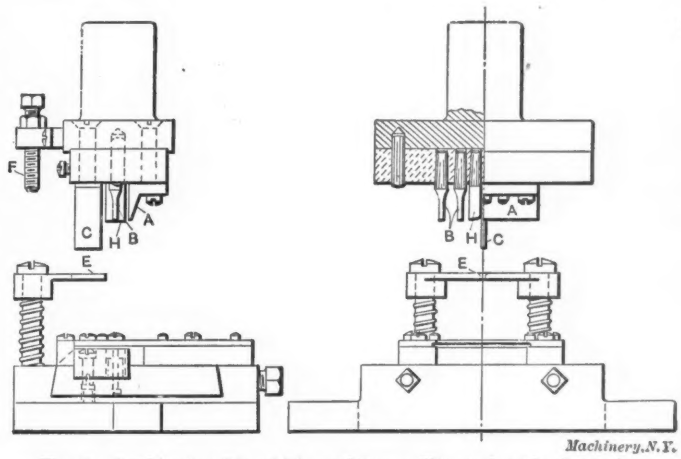


Fig. 2. Combination Die which produces a Clip such as is shown in Fig. 1, at each Stroke.

was adjusted so as to force the clip in a forming slot 9/16 inch, which was enough to fold the sides up correctly. For stripping, a sliding, spring-return stripper *E* was used, which was forced downward by an adjustable set-screw *F*. The method of holding the punches, except the forming punch, is quite a departure from the usual method; they were simply made a slight taper, and fitted to the taper holes in the punch-holder block. Some might question the advisability of trusting to a taper to hold a punch during stripping, but in this case the resistance to stripping is comparatively slight and the punches are kept tight by the action of punching. To produce the catch *G* (Fig. 1) in the clip, the punch *H* was ground to the correct form, and a hole was cut clear through the die, thus allowing for grinding, and a small rubber actuated push-out was inserted which would lift the blank high enough to enable the catch, or step, to pass the edge of the die. This punch was made just long enough to cut the metal almost through, which gives a sharp, clear step as high as the metal is thick. At the bottom of the forming slot a rubber operated push-out was also placed. After the clip is formed, this works it upward about 1/16 inch, which is sufficient to loosen it owing to a slight taper in the forming slot. The clip holds to the forming punch and is drawn out and stripped. The most important practical points have now been described.

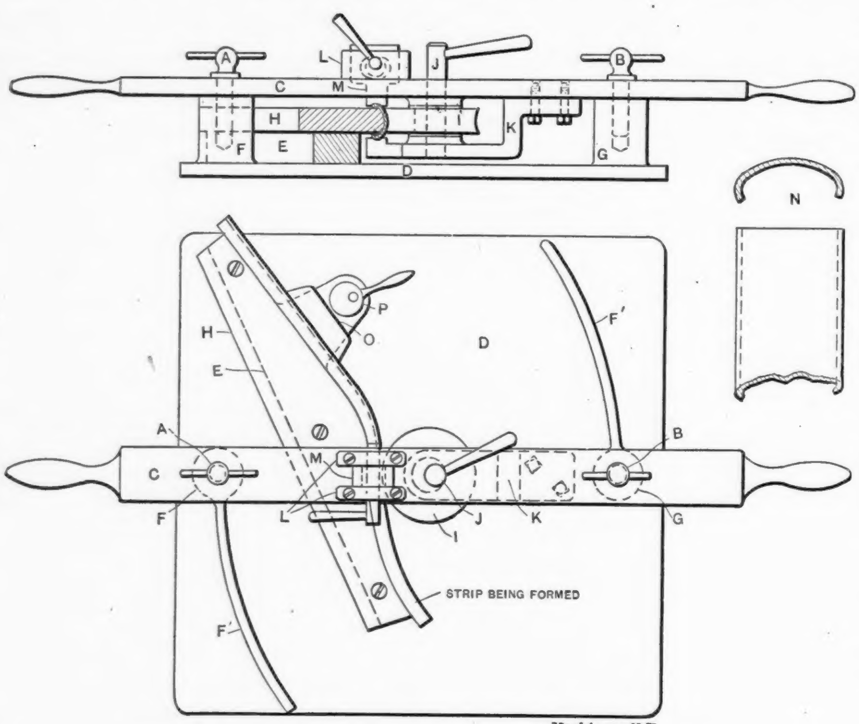
In operation, the brass strip is fed forward by the feed; then it is cut off by the shear *A*, and punched, simultaneously.

This loose piece is then pushed along over the forming slot, by the next feed of the brass strip, where it is folded by the forming punch *C*, after which it is withdrawn, stripped, and as the press is inclined, the clip falls clear of the die. The guides were made only slightly larger than the thickness of the brass strip thus avoiding any possibility of the pieces getting jammed, or riding. GEO. P. PEARCE.

Exeter, N. H.

BENDING DEVICE.

The brass trimming used on an automobile dash is shown at *N* in the engraving. This strip is made of 18-gage brass, and is formed to the curve shown in the cross-section, under a punch press; it is then bent to conform to the curves on the dash. The strip shown in place in the bending device shows the shape of the bend. This is a difficult bending operation, as any change in the shape of the cross-section or marks or wrinkles of any kind will not pass inspection, so that the job requires more than the ordinary bar-and-roller



Machinery,N.Y.
Device for Bending Brass Trimming similar to that illustrated at N.

former to turn the pieces out in large quantities and perfect.

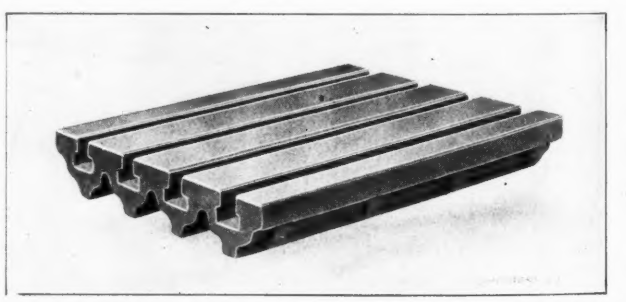
Referring to the engraving, base plate *D*, bosses *F* and *G*, ribs *F'* and pad *E* are cast in one piece. A machine steel forming shoe *H* is fastened to the pad *E*. The clamping block *O* is mounted on the pad *E*, and is actuated by the eccentric clamping lever *P*. The cast iron bending lever *C* is drilled to receive the steel plugs *A* and *B*, these plugs acting as pivots about which the bending lever swings when forming the bend. An eccentric shaft is mounted in the pieces *L*, which gives a vertical movement to a pressure bar or foot *M*. A corresponding foot on the end of bracket *K* takes care of the bottom roll. A machine steel forming roller *I* revolves on an eccentric shaft *J*. By means of this eccentric shaft the pressure on the work can be regulated, and the roller can be backed away from the work when it is formed so that it can be removed. The thin ribs *F'* are machined on the top, and act as slides or rests for the bending lever *C*. The forming operation is done in the following manner: The first bend is made with plug *A* in place, plug *B* being removed. Bending bar *C* is moved to the starting position, pressure foot *M* is lifted and the forming roller *I* drawn back by means of the eccentric shaft. The strip is then inserted between the roller *I* and the forming shoe *H* and against a stop at the end. The stock is held in place by means of the clamping block *O*. The pressure foot *M* and forming wheel *I* are now brought against the stock and the first bend is made. The hole in the bar *C* now coincides with the one in the boss *G*, and the pin *B* is inserted and *A* withdrawn. Before starting the last half of the bending operation the forming wheel *I* is slightly released so as to relieve the sudden stretch in the metal, but during the bending the pressure is again applied. It will be seen that the stretching of the metal takes place on a line over the entire cross-section; however, owing to the temper of the brass a slight spring is bound to take place causing a difference in the pieces. After the bend is formed the foot *M* and the roll *I* are withdrawn by turning the eccentric shafts, and the strip is removed. J. W. BROWN.

DRILLING PLATE, OR AUXILIARY DRILL PRESS PLATEN.

The accompanying illustration shows one of the handiest devices to be found in the machine shop, and one whose advantages are not appreciated to anything like the extent they should be. This device, which we call a "drilling plate," is a sort of supplementary table to use with the drill press. The upper face is provided with four T-slots to which the work is clamped by bolts and straps, or other convenient means. The bottom of the plate is formed by a planed ribbed surface, which rests on the regular table of the drill press. This ribbed base gives a much better bearing on the table than would be the case if the base had a full unbroken surface, as it permits the chips to be pushed to one side in the space between the ribs. The construction also makes a much lighter casting without sacrificing its rigidity.

The great advantage of this device is in connection with light work, in which two or more holes are to be drilled, reamed, faced or tapped, and which is of such shape as to require bolting down in order to keep it in proper position. Such work, if bolted on this plate, can be moved to bring it in correct alignment under the drill with the greatest ease, and in very much shorter time than is possible if the work is bolted to the drilling machine in the regular way. While the machine has all the adjustments required for centering the drill with the work, it is not always easy to make these adjustments; especially if the desired point comes near the center of the pivot of the table.

The device also permits the work to be shifted from one position to another with much greater exactness, thereby insuring more accurate drilling with less wear on the edges of the drill and the sides of the jig bushings. In such drilling as has been described, which easily comprises the majority of that found in the average shop, this plate will save from 15 to 50 per cent of the time consumed for the job, to



Auxiliary Drill Press Platen which Facilitates shifting Work in which several Holes are to be Drilled.

say nothing of the saving on breakage and wear and tear of the drills and drill jigs. We have found that the workmen in our shop would do without any of the other conveniences of manipulation found in the modern drilling machine rather than forego the use of this device.

Notwithstanding its easy moving qualities, this plate has weight enough to prevent it from being whirled around, and also enough to keep the work from lifting and allowing the

drill to gouge in, with the attendant danger of breaking the tool. We make them in three sizes, 12 x 15, 14 x 18, and 16 x 20.

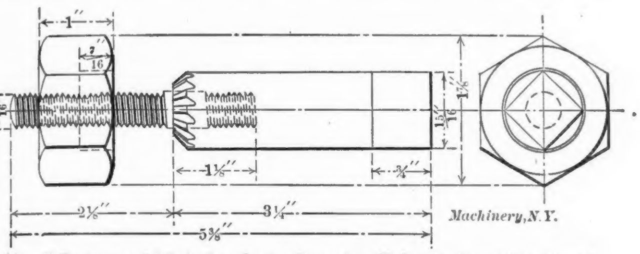
W. H. SHAFER,

Cincinnati, Ohio. Supt. Cincinnati Machine Tool Co.

[Another use to which the supplementary drill press table may be put is that of increasing the product of a drilling department without increasing the number of machines. Two of these plates may be provided for each drill press, so that a workman may be setting up work on one plate, while the other is in position on the machine and the work is being operated on. A skillful man may be required for the setting up, as would be the case under any circumstances, while the actual using of the drill press may be entrusted to a workman of somewhat less ability, thus making a saving in wages as well as a saving in the capital invested in the machinery.—EDITOR.]

DEVICE FOR REAMING HOLES IN ECCENTRIC STRAPS.

In a great many railroad shops it is the practice, when resetting valves, to lengthen or shorten the blades of the eccentric by means of changing the holes in the straps. Under most locomotives there is very little room to work, and when it becomes necessary to change the holes in an eccentric strap arm a slight amount in order to lengthen or shorten the rod's position, the old way of chipping is often very tiresome, inaccurate, and the limited space between the



Small Reamer which is handy for Reaming Holes in Eccentric Straps when setting Locomotive Valves.

eccentrics makes the whole work unsatisfactory. The little reamer shown in the engraving, was designed to be used in connection with this operation. After setting the valves and tightening the middle bolts, remove the others and put the reamer in place. Screw on the feed-nut and turn the reamer with a monkey-wrench. If the reamer feeds too fast, slack up on the feed-nut at the same time that the reamer is being turned. In this way the holes can be easily reamed.

Two Harbors, Minn. AUSTIN G. JOHNSON.

CARELESS CIRCULAR DISTRIBUTION.

I have received circulars of woodworking machinery without any maker's name thereon. Probably the makers sent out a thousand or more in the same condition.

In this connection I would suggest that certain of the manufacturers revise their mailing lists. I get circulars sent to my 1894 Dresden address. Since then I have spent a year in Paris and six in Hanover. ROBERT GRIMSHAW.

Dresden, Germany.

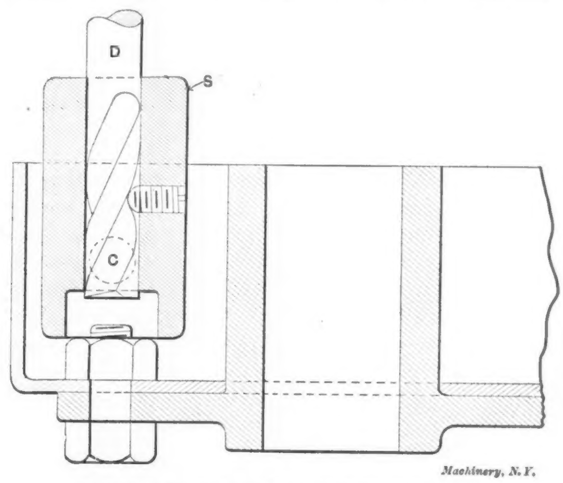
TOOLS WITH HIGH-SPEED STEEL CUTTING EDGES WELDED TO MACHINE STEEL SHANKS.

The welding of high-speed steel to tool shanks of cheaper steel has recently been spoken of as a novelty. That methods for accomplishing this are by no means new must be common knowledge to many practical men. At least one case may be mentioned dating as far back as 1904. The writer was being shown the locomotive works of Borsig at Tegel, near Berlin, and on questioning his guide as to the consumption of high-speed steel the latter replied: "A great deal, but comparatively little," and lifted the first planer tool in sight, saying, "We weld on that tip of high-speed steel; the weld, you observe, is quite invisible," and a rapid sketch in a note book showed the relative size of the welded tip. My informant added: "That is a trade secret. I am sorry I am not permitted to tell you more." From other remarks it appeared that the practice was very successful; but it does not seem probable that Borsig's was the only firm in the world welding high-speed steel tips to their tools in 1904, and it seems very unlikely that one would be justified in saying that, in the past, attempts to weld high-speed steel have been unsuccessful.

Staple Hill Park, Bristol, England. CHARLES R. KING.

CUTTING SCREW ENDS FLUSH WITH NUTS.

The accompanying engraving shows a section of a wheel hub and brake flange held together by eight ⅝-inch bolts, one of which is shown in the illustration. The location of the nuts is in the bottom of the recess formed between the brake band seat and the hub boss, and the end of each bolt stands out originally 3/16 inch outside of the nut. It was required that the bolt ends of these nuts be made flush with the nuts, and as there were a great many of these hubs made, the following process was employed in facing off the ends of the screws. Referring to the illustration, *D* is an ordinary twist drill, the cutting edges of which are ground at right angles to the center line of the body, regular clearance, of course, being given to the cutting edges. In drills of ½-inch diameter, or less, the thickness of the web at the bottom of the grooves is not sufficient to produce any appreciable difference in the pressure necessary for feeding the drills, but on larger drills it became necessary to make the web thinner by grinding the grooves deeper for a short distance back from the cutting edge.



Method of Facing the Ends of Bolts with a Drill.

In fact, a great many tool-makers thin the web on twist drills regularly for ordinary drilling, because it lessens the pressure necessary to feed the drills into the work, and the drill is less liable to spring and drill a hole that is "out of true." In the illustration, *S* is a case-hardened steel sleeve which fits the body of the drill, and is held in place on it by a set-screw entering into the flute. The lower end of the sleeve is counterbored to a depth equal to the thickness of the nut, plus 1/16 inch, and with a diameter sufficient to permit it to pass over the corners of the nut. The cutting edges of the drill project into the counterbored space about 1/16 inch, leaving a distance equal to the thickness of the nut between the cutting edges of the drill and the lower end of the sleeve, which latter simply acts as a stop when facing off the ends of the screws. At *C* is shown a hole drilled through the sleeve to allow the chips to escape. By putting this simple tool into a drilling machine, the bolts are faced off flush with the nuts in a very short time. J. T. GRIMSHAW.

Detroit, Mich.

TAPER GIB DESIGN IN "JIGS AND FIXTURES."

In the August issue of MACHINERY in the fifth installment of "Jigs and Fixtures," by Mr. Einar Morin, two taper wedges or gibs are shown in Figs. 54 and 55. As shown in the illustrations, the wedge cannot be adjusted because it will bind, the screw being inaccurately shown. The usual and correct way of making a taper gib adjustment is to drill and tap for the screw at the same angle as the wedge, that is, parallel to the movement of the wedge. A makeshift method is to drill as shown in the sketch, and to enlarge the hole in the ear of the wedge so that side movement is provided for.

ELMER G. EBERHARDT,

Newark, N. J. Newark Gear Cutting Machine Co.

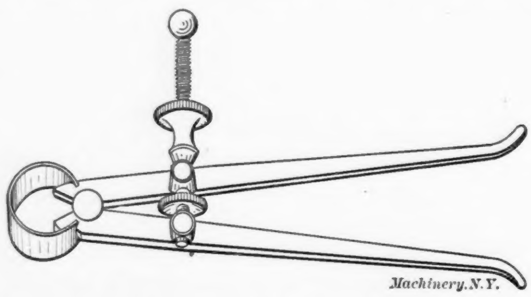
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

LOCK-NUT FOR CALIPERS.

A simple and secure method of converting spring calipers into transfer calipers is shown in the illustration. An extra nut is placed between the caliper legs thus affording means of locking them. This nut can be taken from another pair having the same size fulcrum stud, but a special thin one per-

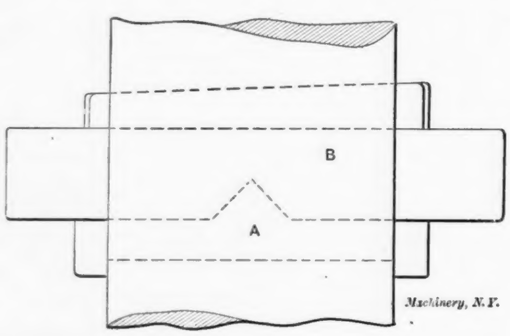


mits the use of the calipers for smaller sizes. The two nuts can be locked and the calipers kept to the same diameter for any length of time, even though carried in the pocket or grip —something very desirable when fitting parts for a job that is far from the shop. DONALD A. HAMPSON.

Middletown, N. Y.

CENTERING SELF-HARDENING CUTTERS.

Self-hardening cutters were to be used in the boring-bar of a large boring mill, and as I am foreman of the tool-room it was "up to me" to devise some way of getting the cutters central in the bar, as there was no way to machine them. This was accomplished as shown in the engraving. The bar was milled flat on each side of the slot, and the centering

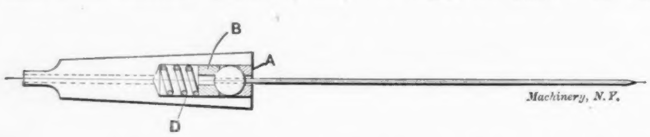


piece *A* carefully fitted to it. The V-shaped tongue on the centering piece, and the corresponding V-slot in the cutter *B* causes the cutter to be set central when it is keyed in place. This job is very satisfactory and preferable to annealing the self-hardening cutters as they are not as durable after having been annealed and hardened again. J. R. WEAVER.

Plainfield, N. J.

HANDY CENTER INDICATING TOOL.

A center indicating tool for locating the prick-punched centers of work true with the machine spindle on a boring mill or a milling machine, may be made as shown in the

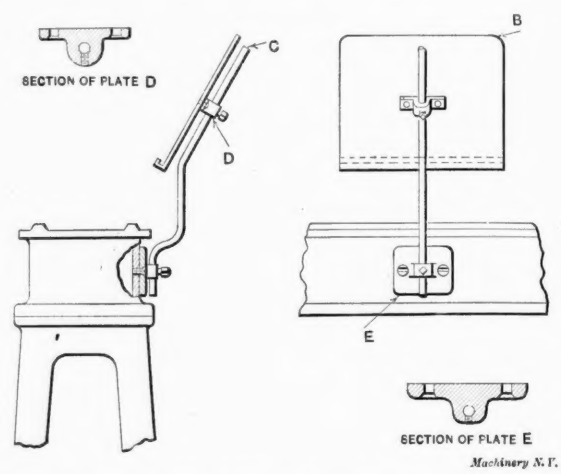


accompanying line engraving. The shank of the tool may be tapered or straight to be held in a chuck. The ball shown at the front end of the hole in the shank is $\frac{3}{8}$ inch in diameter, is hardened, and has a hole drilled through the center in which the pointer is inserted. When using the tool, the shank is inserted in the spindle of the machine, and the end of the pointer is placed in the center hole of the work to be centered. After having been thus located, the pointer is moved back out of the prick-punch hole in the work and the machine started up. If the end of the pointer wiggles or moves about in a circle, it indicates that the center of the work is not in line with the axis of the spindle. The cap *A* in the front of the hole is driven into the hole in the shank, and holds the ball in place. On the other side a bushing *B* is pressed up against the ball by the spring *D*, so that whenever the pointer is set out of line with the spindle, it will be held in this position by the friction between the bushing, ball and cap, caused by the pressure of the spring. There is a small hole through the entire shank to permit the pointer to be driven out of the ball, if required, for repointing.

Poughkeepsie, N. Y. W. W. COWLES.

LATHE BRACKET FOR BLUE-PRINTS.

The bracket shown in the illustration is very simple and will keep blue-prints or working drawings constantly before the mechanic. It is made of two cast iron plates *D* and *E*, rod-arm *C*, bent at any desired angle, and sheet iron holder *B*. The size of screws should be determined by the size of bracket



made. As the reader will notice, there are no breakable parts, and very few loose ones. I would suggest that the surface on the arm *C*, which comes in contact with the set-screws, be filed or milled flat; this will keep the bracket from turning. By using a bracket of this description, the percentage of mistakes made will be greatly reduced and more accurate work done. L. H. GEORGER.

Buffalo, N. Y.

A BLUE-PRINTING KINK.

In the winter months it is hard to judge the time required to make sunlight blue-prints, and so I hit upon the idea of making a scale of colors with which to compare a test piece of paper. Take a piece of blue-print paper four inches wide and ten inches long. Cover all but one inch with a heavy piece of paper. Expose this one inch for say one minute in a mild light, then move the cover so as to expose one inch more for one minute, which exposes the first inch two minutes, and so on, inch by inch, until all ten inches have been exposed, and the first division has been exposed ten minutes. I used a light that I had previously found would print just right in a ten-minute exposure. Any other time interval could be used. Now wash the paper thoroughly, and when dry you have a scale with which to compare other prints. Figure out the relative times that would have been required to bring each color to a perfect blue-print, by dividing the whole time by the time exposed, and mark this number on the color, this number to be used as a multiplying factor. Now, in order to get a perfect print, put the tracing you wish to copy out with a small piece of blue-print paper, and leave it, say two minutes, until it would be printed some, but not enough. Then wash dry with blotters and compare with the scale sheet. Say it was like the fourth color from the bottom. The factor would be $2\frac{1}{2}$. Multiplying this by the two minutes equals five minutes, the time required to make a perfect print in that light. I am pleased with the uniform results obtained. AUSTIN G. JOHNSON.

Two Harbors, Minn.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

FLATHER 30-INCH VERTICAL TURRET MACHINE.

The E. J. Flather Mfg. Co., Nashua, N. H., has recently completed and placed on the market the vertical turret machine shown herewith. As may be seen, it is of simple and attractive design, embodying a number of new features. One of the most noticeable of these features is the use of a cross-rail adjustable for height. In most machines of this size (30-inch swing) the cross-rail is solid with or bolted to the column, at a height that will clear the highest work on which it is expected to use a tool. Under these circumstances, for work close to the face of the chuck, the turret slide has to be extended to nearly the full limit of its travel, making it very difficult to take cuts up to the full capacity of the machine. Other special features of this mill that might be mentioned are a new design of work spindle and bearing, a quick-change gear feed mechanism, the making of the base and column in one casting, the provision for an unusually long cross-slide movement, and the use of a thread and nut feed for the turret slide in place of the usual rack and pinion movement.

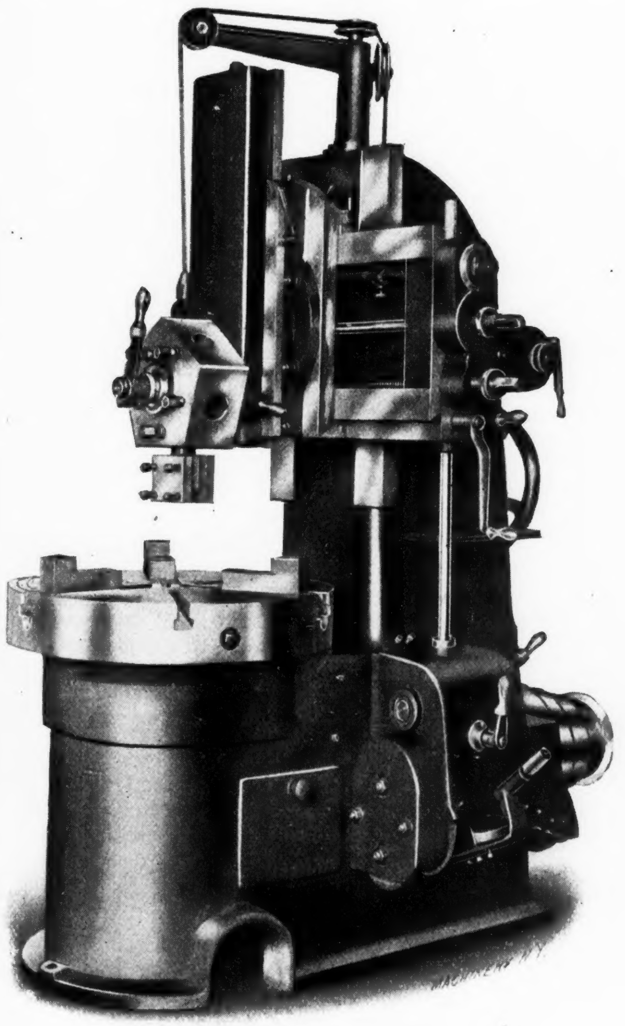


Fig. 1. The Flather 30-inch Vertical Turret Machine.

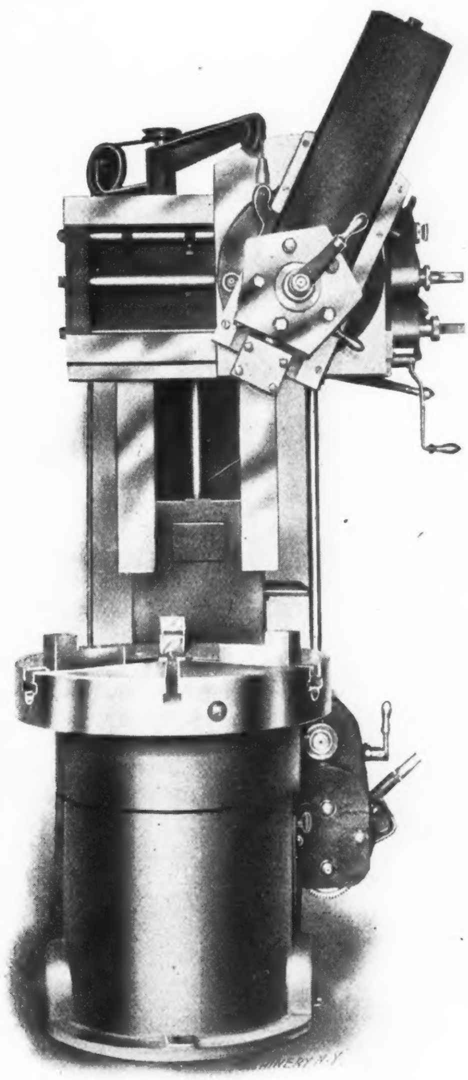


Fig. 2. Front View of Turret Machine.

The Table, the Spindle and the Drive.

In Fig. 3 at *A* is shown the cast iron spindle of the machine, made with thick walls and ribbed in its large diameter so as to be very stiff and strong. The journal for this spindle is formed in two parts. The thrust is taken on the upper beveled face of sleeve *B*, which is screwed and doweled to a machined seat in the solid base of the machine. This thrust bearing, it will be seen, is of large area, and is provided with ample means for lubrication. The side strain is taken by the long bearings of the shank of the spindle in bushing *C*, which fits closely into sleeve *B* on its outside diameter, and is provided with a taper internal bearing scraped to fit the taper journal of the spindle. To the lower end of bushing *C* is threaded the nut *D*, which is split and provided with a clamp screw, as indicated by the dotted lines. To the lower end of spindle *A* are threaded the lock nuts *E E*, which adjust washer *F* against the lower end of *C*. It will be seen that provision is thus made for taking up both the wear of the thrust and the side wear on the journal. By loosening *D*, nuts *E* may be screwed up to give the required tightness of fit for the journal, and then *D* may be screwed up to give the required amount of play for axial motion. The table is 30 inches in diameter, and has 16 changes of spindle speed, obtained by a combination of four-step cone, back gears, and two-speed countershaft. The table is driven by spur gear teeth cut in the periphery of the extended diameter of the spindle, where it is bolted to the table. These mesh with pinion *H* on a vertical shaft, connected by bevel gears *J* and *K* with the driving shaft.

Feed Mechanism and Automatic Stop.

Twelve changes of feed are provided by a quick-change gear device, shown at the base of the machine on the operator's side. The six changes obtained in this mechanism are doubled by a positive clutch, giving the following feeds in revolutions per inch: 7, 8, 9, 10, 11½, 12, 21, 24, 27, 30, 34½, and 36. It should be noted that provision is made for cutting threads of unusual pitches other than those given, by using other gears in place of those provided in the gear casing at the front of the feed box in Fig. 1. The feeds are reversible, and each

rate is the same for either the vertical movement of the turret slide or the horizontal movement of the saddle on the cross-rail.

Worm gearing has been entirely avoided in the feed mechanism. To make this possible in the case of the turret slide, the usual rack and pinion has been replaced with a screw L and nut M, as shown in Fig. 5. The connection with the

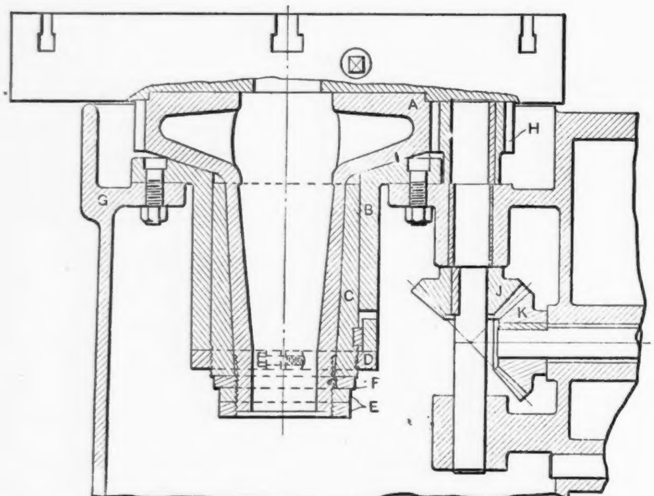


Fig. 3. Vertical Section of Spindle and Table Drive.

splined shaft O in the cross-rail is made by bevel gears through short shaft N; the screw is stationary while the nut revolves, as shown. Both cross and vertical movements are provided with an automatic trip, controlled, in the case of the cross movement, by dogs adjustable lengthwise on a stop rod, which is seen above the splined feed rod in the cross rail in Fig. 1. This rod is also provided with fixed stops at the limits of its motion, making it impossible to overrun the saddle on the cross-slide and damage the feeding mechanism. The feed stop operates on the feed clutch at the rear of the cross-rail, as shown in Fig. 3, dropping it out of engagement when the stop strikes the dog. The movement of the turret slide is controlled by a stop acting on the same stop rod, through the medium of a train of gearing and the index dial, shown at the right end of the cross-rail above the

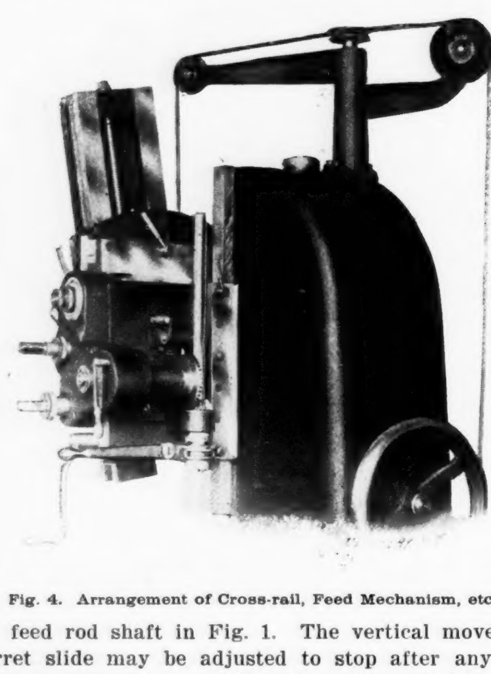


Fig. 4. Arrangement of Cross-rail, Feed Mechanism, etc.

splined feed rod shaft in Fig. 1. The vertical movement of the turret slide may be adjusted to stop after any desired amount of movement, by setting the adjustable dial to read for the desired amount. This mechanism acts on the stop rod to throw out the clutch in the same way as for the horizontal movement.

The Turret and Turret Slide.

The turret slide is, of course, set on a swivel saddle so that the movement may take place at any desired angle. The automatic stop operates at any angular setting of the saddle. The slide is counter-balanced by an arrangement which, it will be seen, is very simple as compared with that provided in many designs of this apparatus. It consists simply of a swinging crane arm carrying idler pulleys so located as to follow the movement of the slide freely. The turret is five-sided, and is 10 inches in diameter. The tools are clamped in place by hardened steel set-screws P, seated in bushed nuts Q. The lock bolt, of hardened steel, works in a hardened steel index ring.

Dimensions.

The principal dimensions of the machine are as follows: The extreme diameter of swing is 32 inches. The cross-rail may be adjusted by the hand wheel shown at the rear of the column in Fig. 4, to give from 8½ inches to 26 inches of height over the face of the chuck. The maximum distance under the turret head is 28½ inches, giving a total adjustment for the cross-rail of 17½ inches. The turret slide has a vertical feed of 17 inches, and is mounted on a cross-slide

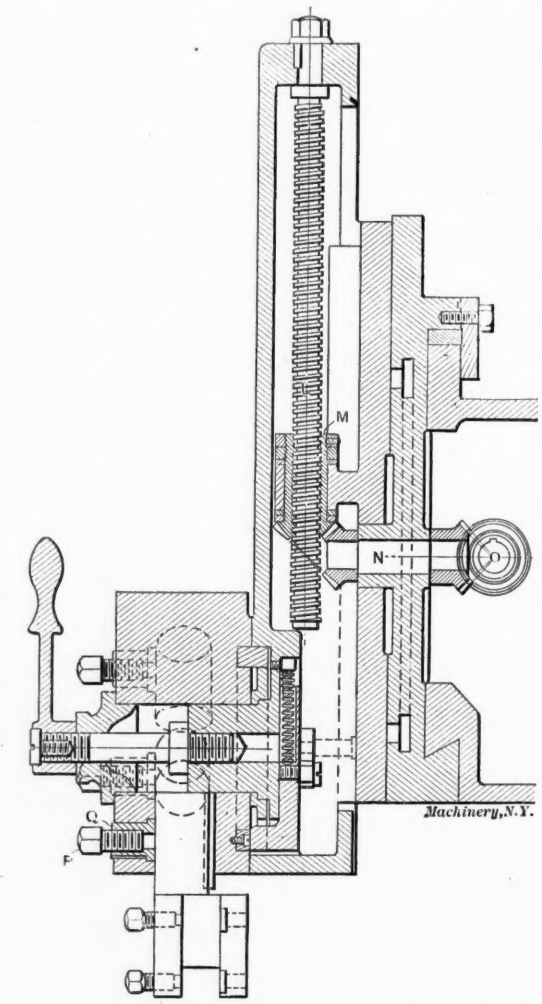


Fig. 5. Section through Turret Slide, showing Screw Feed.

which has a travel of 23 inches, thus making it possible to turn reverse bevels on work of unusually large diameter. The machine stands 88 inches high, and occupies a floor space of about 68 x 47 inches. The approximate weight is 5,300 pounds.

This machine is intended for the regular routine work of the boring mill, and for that reason it has not been encumbered with special features. It may be built at a cost that is reasonable in view of the cutting power and rigidity which the builders have aimed to obtain. The lines of the machine, as may be seen from the engravings, are simple but pleasing.

SOLID ADJUSTABLE THREADING DIE FOR USE ON TURRET LATHES, ETC.

The die-head shown herewith is designed to use a die formed of separate chasers and to so hold them as to give them an adjustment through a wide range of diameters. It is intended for use in machine operations where solid dies or adjustable round dies would otherwise be used.

The adjustment is made very easily, by loosening the front clamping plate and turning the outer hardened hood to the right or left as required, keeping the dies pressed against the inner bearing meanwhile. The seating of the outer edges of the dies against the tapered inner surface of the shell adjusts them simultaneously to a varying diameter as the hardened hood is turned. The chasers are tightened in place by locking the hood with a set-screw, and clamping the front plate up against them. The chasers (which are made of high grade tool steel or high speed steel, as required) are carefully

Die made by Adjustable Collet Co.

tempered, and have a much longer life than one-piece threading dies, since they can be easily and quickly removed from the head and sharpened on an emery wheel or grindstone. They have a slight clearance in the threads which permits them to act freely with no drag. In addition to the advantages of a long life and the solid holding of the chasers, the feature of adjustability is very important, it being possible to use the same set of chasers for a wide range of diameters.

The heads are made of any suitable length to accommodate long threaded work. They may also be furnished with plain chasers and used as adjustable hollow mills. The material and workmanship of the tool is stated by the manufacturer, the Adjustable Collet Co., Cleveland, O., to be of exceedingly high grade, making the device an accurate and durable one.

FOX POLISHING MACHINE.

The accompanying illustrations show a polishing machine built by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich. This machine is of interest in itself, and makes possible, as well, a great improvement in the arrangement and general conditions of the polishing room beyond what is com-

Fig. 1. Fox Polishing Machine with Exhaust into Base.

monly met with in work of this kind. The machine is mounted on a substantial base, to the top of which is mounted a yoke which carries the arbor. This is best seen in Fig. 2. The lever shown at the front of the machine is attached to a shaft carrying an eccentric by which this yoke is raised or lowered. The lowering of the yoke and the contained arbor brings the pulley into contact with the belt, and starts the machine. To stop the machine, the lever is thrown back; this raises the pulley away from the belt, and brings the band brake, shown at the right of the pulley in Fig. 1, into operation, instantly stopping the spindle. The connecting-rod from the eccentric to the yoke is adjustable in length so that the belt may be brought down to exactly the right tension when the lever is thrown in, thus avoiding the necessity for treatment with resin or special preparations. The spindle or arbor is mounted in Hyatt roller bearings. The fit is a close one, but leaves enough freedom so that the spindle may be spun between the end of the thumb and finger. The use of these bearings in this machine has been very successful, and has led the builders to adopt them for their entire plant. In spindles running as fast as those used for polishing, a small amount of friction means a considerable amount of power, so that the matter of getting good bearings is an important one. The rollers and casings of the bearings are ground for high speeds, and are thoroughly protected against dust and grit.

Fig. 2. Side View of Base, showing Belt Tightener and Brake.

Each machine is provided with a pair of substantial steel dust hoods, attached to flanged brackets which are bolted to the column of the machine. The dust is exhausted from these hoods through brackets down into the column. From here it may be either led away through exhaust ducts in the floor, or through an opening at the rear of the base. The hoods are hinged so as to open up to permit the removal and insertion of polishing wheels.

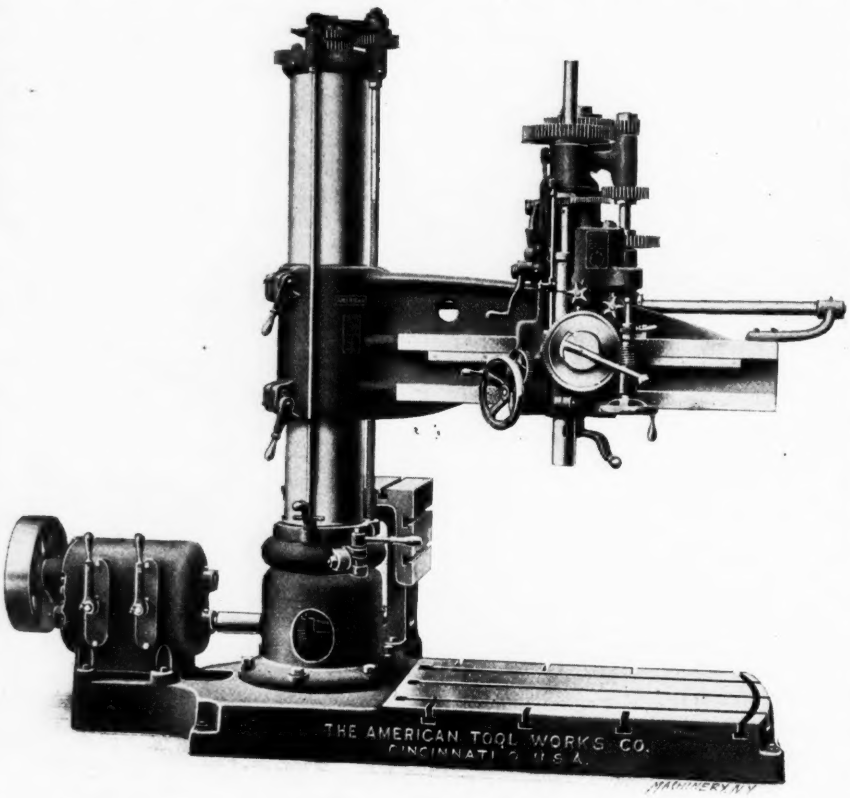
In designing the machine, it was the object of the manufacturers to produce a tool which would stand continuous service without requiring repairs. Really remarkable results have been obtained on this score. Ten machines of this type have been in constant use in the shops of the builders for about four years, most of them with two operators to a machine. It is stated that in that time the cost of repairs has not exceeded 25 cents; there has not been a single hot bearing, nor has one of the bearings ever been adjusted.

AMERICAN TOOL WORKS CO. HIGH-SPEED RADIAL DRILL.

The accompanying illustration shows one of a new line of radial drills designed and built by the American Tool Works Co., 300-350 Culvert St., Cincinnati, O., in order to take advantage of recent developments in high-speed drills, especially those of modified flat drill form like the "Celfor," "Norka," and other types which we have described from time to time. These drills have been developed until, with proper machinery for driving them, they will pierce a hole practically as quickly as it can be punched, in the case of work where punching is practicable. The radial drill has been steadily growing in favor for general work, owing to the convenience of its operation, and the facilities it offers for presenting to the tool, work of all shapes and sizes. The drive of the machine, however, has of necessity to be so long and complicated that in previous designs it has been impossible to bring from the driving pulley to the point of the tool, sufficient power to use these new high-speed drills to their full capacity. By strengthening the machine generally, improving the feed, and providing triple back gearing at the spindle head, the makers of this machine believe that they have provided a radial drill which obviates the defects of previous designs.

General Design.

The general design follows that of the 2-foot radial drill built by the same firm (see "New Machinery and Tools" in the July, 1908, issue of MACHINERY), and so will be only briefly described. The column is of the double tubular type with the outer sleeve revolving on conical roller bearings, hardened and ground. The inner member extends to the full height of the column, and has bearings at both top and bottom. This gives the equivalent of a double column and makes a very rigid support. The base is very heavy and is strongly ribbed, especially at the point of support. An extension of the base at the back is drilled to receive a plain box or a universal table, as ordered. The arm is of combined parabolic beam and tubular section, giving great resistance to bending and torsional strains. Its design leaves its lower edge parallel with the base, permitting work to be operated on in close proximity with the column without requiring the spindle to be unduly extended.



A Radial Drill Especially Designed for using the New Forms of High-speed Tools.

The Drive.

The machine illustrated has a speed box drive, though it will be furnished with a cone pulley instead, if desired by the purchaser. This speed box, by the operation of the two levers shown, provides four speed changes, all controlled by friction clutches, which permit a change of speed without stopping the machine. From the speed box, power is transmitted in the usual way to the splined driving shaft shown extending along the back of the arm. The connection between this splined shaft and the driving shaft of the head is effected through a reversing mechanism operated by friction clutches, and controlled by the lever seen projecting forward toward the operator's position from beneath the cross-rail. The locating of the reversing arrangement here between the speed box and the triple back gears gives the clutches the advantage of a high speed even on slow, heavy work, thus providing them with ample power for the most severe conditions the machine will be called on to meet. This arrangement also facilitates the use of the reversing lever in combination with the back gear lever for tapping, giving a slow forward movement and a quick reverse. The triple back gears (a construction which, so far as our memory serves us for the moment, is a novelty in radial drill construction) are located in the head close to the spindle. The use of triple gears and the placing of them in this position is a prime factor in the matter of bringing a sufficient amount of power to the point of the drill, as it makes this possible without requiring transmission shafts of unwieldy size, and the transmission of high torque through sliding keys.

The drive just described provides for twelve changes of speed, the four in the speed box being tripled by the triple gears. This number is doubled by the use of a two-speed counter-shaft, giving 24 changes, which range in geometrical progression from 18 to 346 revolutions per minute, all immediately available without stopping the machine. This wide range of speeds, in conjunction with the high driving power, makes the machine as useful for the lighter work as for the heavy service for which it has been particularly designed. Particular attention should be called to the fact that the changes can be made without stopping the machine. The counter-shaft and speed box changes are effected by friction clutches which, of course, can be operated without shock at any practicable speed. The triple back gears are provided with a special feature which in combination with the rounding of the edges of the teeth of the gears, permits throwing them in at high speed with practically no shock to the parts. These arrangements make possible very rapid manipulation of the machine without any danger of breakage.

The Feeding Mechanism.

This machine is provided with eight rates of feed, covering a range in geometrical progression from 0.0066 inch to 0.0633 inch. These feeds are all obtained by the shifting of the knobs shown below the feed box. The dials with which these are provided indicate the rates of feed directly, making unnecessary any reference to index plates before making the change. These feeds are geared and positive, thus insuring a maximum productive capacity. The friction connec-

EXAMPLES OF TESTS MADE ON AMERICAN HIGH-SPEED RADIAL DRILL.

DRILLING TEST IN CAST IRON TWO INCHES THICK.

Size Drill.	Speeds.		Feeds.		Back Gears.		Actual H.P.
	Revolutions.	Cutting Speed.	Per Rev.	Inches per min.	Ratio.	Position.	
$\frac{1}{2}$" C.	356	46.6'	.046	16.3	1.48	Top	5.75
1" C.	216	56.6'	.046	9.9	1.48	Top	5.45
$1\frac{1}{32}$" H.S.	313	84.5'	.046	14.4	1.48	Top	13.2
$1\frac{7}{32}$" H.S.	313	99.8'	.046	14.4	1.48	Top	15.3
$1\frac{15}{32}$" H.S.	216	83.1'	.033	7.1	1.48	Top	12.6
$1\frac{23}{32}$" H.S.	216	97.0'	.033	7.1	1.48	Top	16.8
$1\frac{31}{32}$" H.S.	128	66.0'	.033	4 22	4 22	Middle	15.6
$3\frac{1}{2}$" H.S.	60	55.0'	.024	1 44	4.22	Middle	10.2

DRILLING TEST IN STEEL ONE INCH THICK.

Size Drill.	Speeds.		Feeds.		Back Gears.		Actual H.P.
	Revolutions.	Cutting Speed.	Per Rev.	Inches per min.	Ratio.	Position.	
$\frac{9}{16}$" H.S.	356	52.3'	.012	4.27	1.48	Top	4 2
$\frac{3}{4}$" H.S.	313	61.5'	.012	3.75	1.48	Top	10.8
$1\frac{1}{32}$" H S.	188	50.9'	.024	4.51	1.48	Top	9.0
$1\frac{5}{32}$" H.S.	188	56.9'	.024	4.51	1.48	Top	9.3
$1\frac{23}{32}$" H.S.	128	57.6'	.024	3.07	4.22	Middle	8.4
$1\frac{31}{32}$" H.S.	167	86.2'	.012	2.00	1.48	Top	7.8

TAPPING TEST WITH PIPE TAPS IN CAST IRON TWO INCHES THICK.

Diameter Tap.	Speeds.		Feeds.		Back Gears.		Actual H.P.
	Revolutions.	Cutting Speed.	Per Rev.	Inches per min.	Ratio.	Position.	
4"	18	21.2'	$\frac{1}{8}$"	$2\frac{1}{4}$	12.02	Bottom	6.6
5"	18	26.2'	$\frac{1}{8}$"	$2\frac{1}{4}$	12.02	Bottom	7.7
6"	18	30.8'	$\frac{1}{8}$"	$2\frac{1}{4}$	12.02	Bottom	9.0

Note: C = carbon steel, H.S. = high-speed steel.

tion is provided, however, between the feed work and the feed pinion shaft. While this is strong enough to carry, without slipping, the heaviest feed the tools are capable of standing, it will serve as a safety device to prevent any damage to the feed mechanism. The spindle sleeve is provided with a depth gage and automatic trip acting on the v orm clutch. The graduations being on the sleeve, the reading of depths is very simple; all depths can be read from zero. Two or more tripping dogs can be supplied, making it possible to counterbore a number of holes without reversing. The trip acts automatically at the extreme of the feed, preventing possible damage to the feed mechanism. The spindle is easily handled, being counter-balanced and provided with a quick advance and return lever, as well as with a fine hand adjustment, which may be used as well for hand feeding.

In the tables are given some examples of tests which indicate the power consumed under various severe conditions of service and illustrate as well, the capacity of the machine for transmitting this power. The driving of a 6-inch tap is an interesting illustration of the possibilities of the machine.

Unless otherwise specified, this radial drill is furnished with plain box table, counter-shaft and cone pulley drive. At extra expense it will be provided with the speed box as described, a universal table, and an electric motor drive. It is particularly adapted to the use of the latter, as it is only necessary to mount the motor on an extension of the base opposite the speed box, to which it is connected by chain or gearing.

STOCKBRIDGE GEAR-DRIVEN SHAPER.

The Stockbridge Machine Co., of Worcester, Mass., has recently designed a shaper with a drive in which all the changes of speed are effected by changes of gearing, thus adapting it either to be used as a constant speed pulley machine, or to be driven by a constant speed motor. The machine is designed new throughout, instead of following the plan sometimes adopted of taking a standard form of shaper and adding a gear box to it. Fig. 1 shows this machine as designed.

The Speed Change Gearing.

The construction of the gear box, which is, of course, the vital feature of the new design, is indicated in the vertical section in Fig. 2, which shows the pulley-driven arrange-

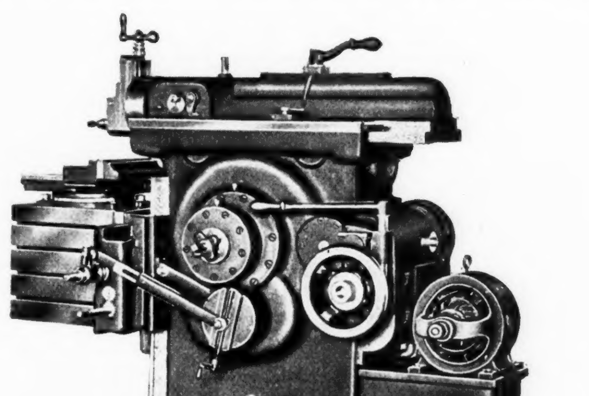


Fig. 1. Stockbridge Shaper, arranged for Motor Drive.

ment. Power is received at pulley A, which is fastened to the driving shaft B. To the latter are keyed a series of five gears, C_1, C_2, etc. These engage corresponding gears D_1, D_2, etc., mounted on a stepped steel sleeve E, which is journaled in ring oiling bearings at F and F in the casing. In the bored interior of sleeve G (to which pinion D_1 is keyed) and on the interior periphery of each of the gears D_2, D_3, D_4 and D_5 is a series of cast iron expansion rings H_1, etc. These are expanded by the wedge-shaped plungers J_1, etc., whose lower ends are raised by suitable cam surfaces in rod K. The speed changes are "selective"—that is to say, any one of the changes can be obtained without going through the intermediate steps between it and the last previous change. In making a change, knob L is rotated, revolving K to bring the proper cam surface into agreement with the proper plunger to operate the clutch desired, giving the speed indicated by a dial surrounding knob L on the hub of hand-wheel M. The plunger thus brought into alignment with the cam on K is then raised and the clutch tightened, by shifting K end-wise. This is done

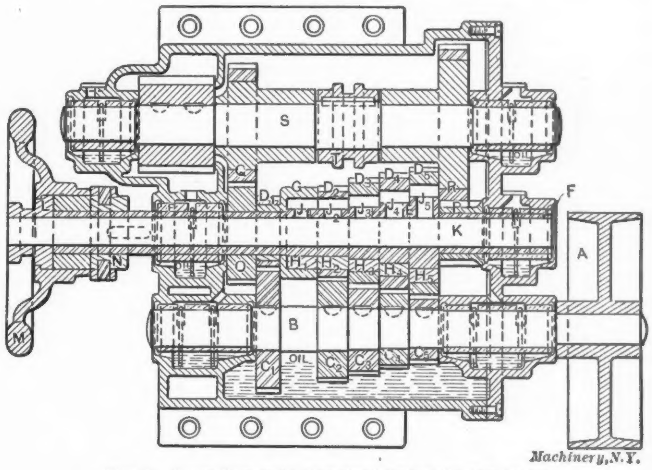


Fig. 2. Gear Box with Constant Speed Pulley Drive.

by a clutch fork operated by the horizontal handle shown above the hand-wheel in Fig. 1, engaging sliding collar N shown in Fig. 2. This shifting of K thus binds any desired one of gears D with sleeve E, which is thus driven at a corresponding speed from shaft B. On E are keyed pinions O and P, meshing with gears Q and R respectively, which run loosely on the crank-gear pinion shaft S. A clutch T operated by a lever at the rear of the change speed box engages either Q or R with S, this in effect being a back gear change. It will be seen that ten rates of speed are thus obtained.

The details of this gear box have been carefully worked out. The gear teeth are all cut in steel, excepting in the case of the driving pinion of the crank gear. The friction rings H may be adjusted for wear by means of screws reached through a hand-hole at the back of the gear box. The gears run in oil and the boxes are all bronze bushed and provided with ring oiling facilities. The handwheel M will be found useful in moving the ram by hand for fine settings. The dial which shows to what position knob L has been turned, is marked with numbers giving strokes of ram per minute for each of the five gears D. Locating this gear box at the back of the shaper and bolting it direct to the column makes a stiffer, as well as a more compact construction than the more common one in which it is built out from the side of the shaper.

General Features of Design.

As was stated, the machine has been newly designed for this new gear drive to give it the necessary stiffness to make all the increased power of which it is capable, useful at the point of the cutting tool. A number of new features of the design may be mentioned. One of them is the construction of the rocker arm, of which a cross section is shown in Fig. 3. As may be seen it is provided with a cored U-shape rib on either side, giving as rigid a construction as could well be made for this part. The slot is of unusual depth and width, giving ample bearing surface for the crank-pin block. The rocker arm is held between two boxes at the bottom and is tied to the ram at the top, preventing the possibility of any tendency to come out of alignment.

The ram itself has been strengthened and stiffened over previous designs. On the working side the gib is solid with the column. On the other side it is made complete in one piece and bolted solidly to the column. Taper packing is provided for taking up wear and the whole construction adds considerable to the stiffness of the shaper.

The method followed of attaching the saddle to its slide on the face of the column is new in shaper construction, though it is exactly identical with that which has been followed for

a long time in the similar bearing on the column-and-knee type of milling machines. It is believed by the builders to give a much superior construction to that ordinarily followed for shapers, as it gives one bearing surface cast solid with the saddle or cross-rail, and this, in combination with the method of tightening provided, prevents all possibility of the cross-rail's tilting away from the column when the gib on the opposite side is loosened. The adjusting gib is on the working side of the machine and is locked by the tightening of two binder screws, which serve to make the cross-rail practically a part of the column. This arrangement also makes it unnecessary for the operator to go around to the further side of the column to tighten the binder bolts, as is necessary when two loose gibs are used.

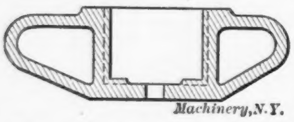


Fig. 3. Cross-section of Crank.

The regular distinctive features of the Stockbridge shaper are continued in this machine. Among them is the automatic down feed which was illustrated in the department of "New Machinery and Tools" in the November, 1907, issue of MACHINERY. The crank motion provided on this machine is well known. It gives a very even cutting speed for the entire length of the cut and a quick return of between three and four to one. This is obtained without jar to the machine, as the high speed is gradually brought to zero at either end, reversing the stroke easily and smoothly.

For the pulley drive machine, the construction shown in Fig. 1 is modified by using a regular base instead of the extension base there shown for supporting the motor. The driving shaft then has mounted on it a single diameter pulley, as shown in Fig. 2 instead of the geared connection for the motor used in Fig. 1.

KRIEGER BORING TOOL AND HOLDER.

The boring tool shown herewith is built by the Krieger Tool & Mfg. Co., 83 to 91 West Randolph St., Chicago. Its particular advantages are the firmness and convenience with which the boring tool may be held and adjusted, and the simplicity of its attachment to the lathe.

The bracket on which the tool is held may be slipped over the tool-post, and clamped by a square block passing through the tool-post slot and tightened down by the regular screw. The boring-bar holder proper is attached to the face of the bracket by bolts passing through the slots shown. This may be raised or lowered to bring the tool to the proper height, by means of the screw shown, which provides for very fine adjustment in a vertical direction. The holder is in the form of a V-block having a V-clamp supported by it, which is clamped down on the tool by the stud and nut shown. This is adapted for a wide range of boring-bars (from 1/4 up to 1 1/4 inch) which it will hold so firmly as to prevent any possibility of turning.


A Universally-adjustable Boring Tool Holder used in the Regular Tool-post.

These boring-bars have been previously described (see "New Machinery and Tools") in the April, 1908, issue of MACHINERY. The blades, formed of simple pieces of square stock, may be set in either of two positions; they may be inclined, as would be necessary to recess the bottom of a blind hole, for instance, or set straight, as would be done in machining a cored hole large enough to admit the boring-bar. The blade is clamped in place by the thumb screw at the back end of the bar, there being no headless set-screw or other delicate contrivance of that kind at the business end of the tool.

With this holder the bar can, of course, be accurately lined with the center of the spindle, and extended to a distance just sufficient to reach the bottom of the hole which is being bored, thus giving the maximum degree of rigidity to the tool support.

TOOL-HOLDER FOR HIGH-SPEED STEEL.

The cutting tool shown in the accompanying engraving is the invention of Mr. F. E. Bocorselski, the superintendent of the Baush Machine Tool Co., of Springfield, Mass., who manufactures the device. It is made in two styles, of which the first, shown in Fig. 1, is adapted for more severe service. In each case the holder D is made of 20-point carbon steel, case-hardened, and the blade is drop forged from high-speed cutting steel. This makes a durable and effective tool.

In the style shown in elevation and perspective, in Fig. 1, the drop forged blade C is provided with a tenon, as shown,

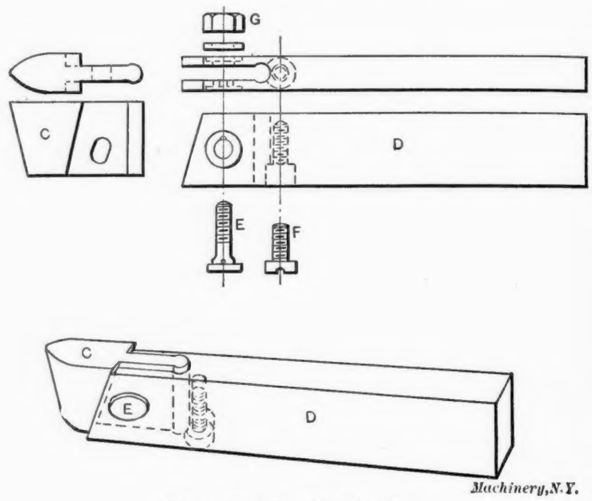


Fig. 1. Details of Tool-holder.

entering a corresponding mortise in the holder D. The front end of the latter is cut off at an angle, as shown, and the tenon of the blade is beveled to fit this angle; the rear end of this tenon is provided with a bead fitting a hole drilled through the shank into which the slot is cut. The blade may thus be set into its seat from the top and tapped into place, when it will fit firmly on all its bearing surfaces in the shank. To hold it in position sideways bolt E is used, which clamps the thin sides of the holder firmly against the shank of the blade. One advantage of this construction is the large bearing area and intimate contact between the blade and the holder, which permit the rapid conduction of the heat. The two parts, it will be noticed, are of the same height and section, so that the full cross-section of the holder is available for this purpose. An ejector screw F is used for removing the blade for grinding or changing cutting edges. This, it will be seen, may be screwed up against the under side of the tenon of the blade, ejecting it from its wedge seat in the holder after bolt E has been removed. This screw may also be used to give a more firm support to the blade by screwing it up against the blade after clamping it in place.

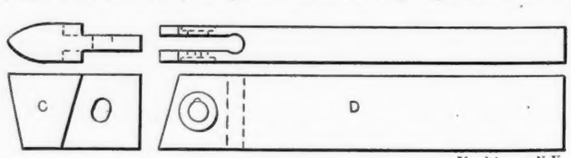


Fig. 2. A Holder of Simpler Construction.

The other form of tool-holder, Fig. 2, is without the ejector screw and the bead on the tenon of the blade, the bolt and the bearing of the taper seat of the blade against the end of the holder being relied on to hold it in place. This

holder, which is doubtless intended for lighter service, is identical in other respects with that in Fig. 1. The blades, drop forged from high-speed steel, are made of various other forms, as well as in the shape shown in the engraving, for turning cast iron, thus fitting them for the full range of lathe work.

FERRACUTE DRAWING PRESS FOR METAL CASKETS.

The Ferracute Machine Co., of Bridgeton, N. J., has recently completed the remarkable double-action drawing press shown herewith. It was built for the Montross Metal Casket Co., of Philadelphia, and, as may be surmised from the firm name of the purchaser, is intended for blanking and forming the cover and body of seamless metal caskets. Examples of its work are shown on the floor around the base of the machine. The machine is, of course, as useful for producing similar work in other and less lugubrious lines, such as bath tubs, horse troughs, automobile bodies and miscellaneous large drawn work in steel or copper. The machine is interesting because of its large size (it weighs nearly 100 tons and is capable of exerting a pressure of 1,000 tons) and for the mechanical features of its construction as well.

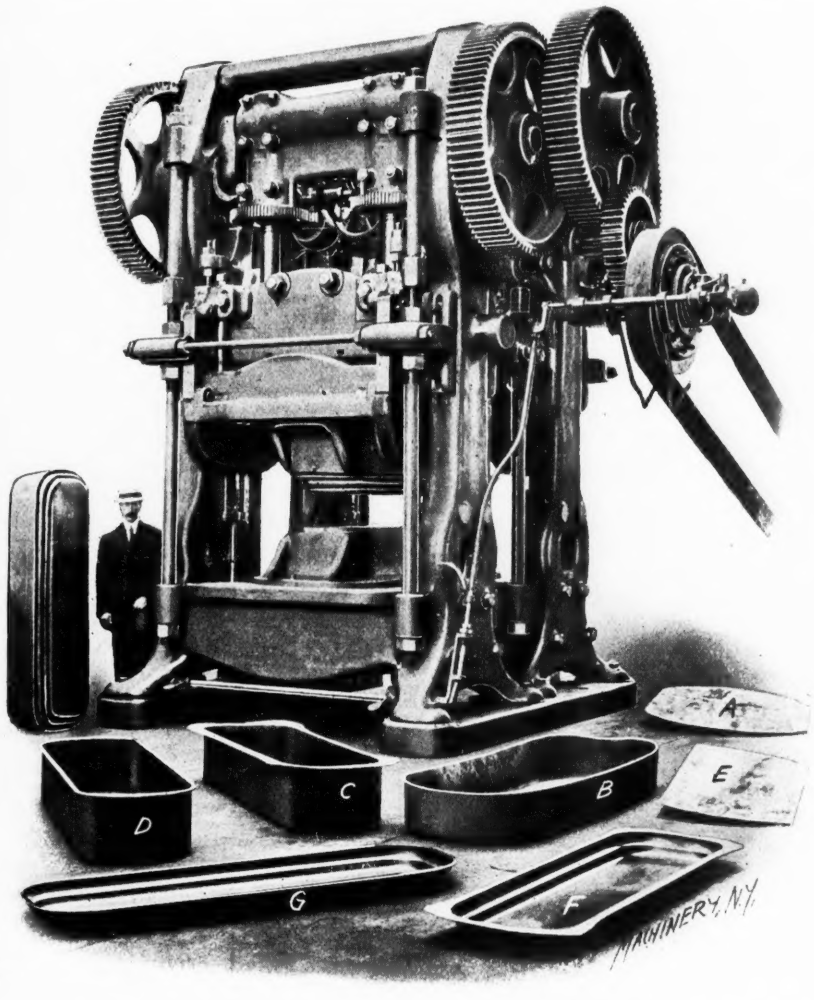


Fig. 1. A Press for Drawn Work of the Largest Size; Built up from Two Presses on the Same Base.

This press is virtually formed of two separate presses, mounted on an iron base. The frame is thus composed of four heavy cast iron columns, each of which is reinforced by two 4¾-inch steel rods, which add materially to the tensile strength of the columns. Besides being united at the base by the bed, these columns are connected at the top by stays, and by the necessary mechanical connections for the mechanism. The construction allows vertical pressure to be communicated to the table ram at four points, there being two crank-shafts, with double pitman rods for each. The adjusting gears of the four pitmans are connected by gearing, so that one hand-wheel moves them all; the adjustment is exceedingly delicate, as one turn of the hand-wheel gives only 0.001 inch of movement. A small electric motor, which may be seen in the interior of the machine between the two outer pitmans, is connected with this adjusting mechanism to enable adjustment to be made rapidly when the ram is to be raised or lowered any considerable amount.

The double-action mechanism is unusual and interesting. The outer slide or blank holder is hung from the inner ram by four heavy studs. It descends with the ram for about half of its stroke, when it is arrested by meeting the lower die and the work. At this point the continued descending of the inner die operates a toggle mechanism, forcing adjustable wedges in on top of the blank holder, transferring the pressure directly to the frame of the machine, this pressure not being borne by the main shaft as in ordinary cam presses. The four toggle levers which operate this wedge mechanism are connected with adjustable tie-rods by which the holding down pressure may be varied to suit the conditions of the work. This arrangement has been used by the builders for some time on smaller presses, but has never before been applied to large drawing presses. One advantage of the construction is that in this machine the whole outer ram or blank holder may be quickly removed by unscrewing the nuts from the top of the studs, allowing the outer ram to drop down through from the inner ram. By removing it in this way the machine may be made into a single-action press in which the full power of the ram is available. It is then especially adapted for working cutting dies, owing to the long and accurately adjustable gibbed slide bearings with which the machine is provided. This transformation of a double-action press into one of the single-action type is believed by the builders to be a new feature.

The machine is triple geared, with all the gearing cut from the solid. The five large gears are each 5 feet in diameter and 10 inches face. The ratio of the gearing is 200 to 1. The friction clutch used is of modern design, especially adapted for high speed and heavy service.

As stated, the weight of the press is nearly 100 tons, and it is capable of exercising a pressure of 1,000 tons. The stroke of the inner punch or ram is 28 inches. The outer ram may have, if desired, as much as 24 inches of movement, but with the presses adjusted as shown in the illustration, its stroke of 14 inches is capable of producing a shell of very nearly that depth. The crank-

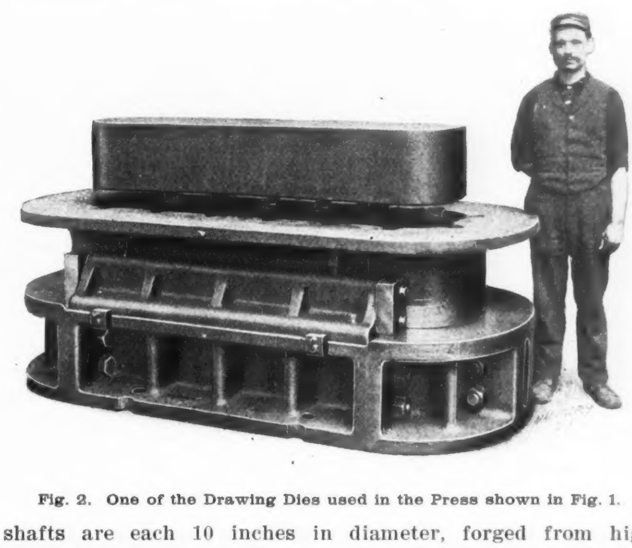


Fig. 2. One of the Drawing Dies used in the Press shown in Fig. 1.

shafts are each 10 inches in diameter, forged from high carbon steel. The pinions are of phosphor bronze. An adjustable positive knock-out attachment is used in connec-

tion with the dies; two of the rods which connect the knockout with the ram are shown in the engraving.

The work shown about the base of the machine is 6 feet long, 20 inches wide, and 12 inches deep for the body of the casket, while the lid is 4 inches deep, giving a total height of 16 inches for the completed article. The parts are arranged in the order of the operations. At *A* is the blank for the body of the casket. This is first rough drawn, as shown at *B*, to a depth of 9½ inches. It is then, at *C*, redrawn to a full depth of 12 inches. The edges are next trimmed, and at *D* the edge is shown formed. The operations on the lid are similar, except that but one drawing operation is necessary, the blank being shown at *E*, the drawn shape at *F*, and a completed cover with trimmed and formed edge at *G*.

One of the drawing dies (that for the last drawing operation) is shown in Fig. 2. It is, of course, of large size, but it has been reduced to minimum dimensions by careful designing. The lower die is shown on the floor with the blank holder resting on it. The upper die, or punch, is shown suspended above that.

WALKER NO. 2½ SURFACE GRINDER.

In the "New Machinery and Tools" department of the February, 1908, issue of MACHINERY we illustrated and described the No. 3 surface grinder built by the Walker Grinder Co. of Worcester, Mass. This machine is now available in a smaller size, the No. 2½ shown herewith. This, besides being of smaller dimensions, incorporates a number of improvements as well, particularly in the feed mechanism.

The main features of this grinder are the same as in the original machine. The work table slides on ways directly on the bed of the casting, while the cross movement is effected by moving the wheel column in or out. The guiding surface of the wheel column is extended, by means of projecting horns, on ways which pass through openings in the rear of the base so that the wheel is supported practically under the working point at even the outermost extreme of adjustment. The table has an automatic reciprocating movement, controlled by the dogs shown which can be adjusted to any desired position in the slot on the front of the table. The cross feed is arranged to feed automatically in either direc-

Fig. 1. Walker Surface Grinder with Friction Feed.

tion at the will of the operator, at each end of the stroke, and is provided with a safety device which prevents the possibility of forcing this automatic movement beyond the limits of the cross travel.

The improvement in the automatic cross feed consists in operating it from a friction device, similar to that provided for planers, instead of having it operated by the reversing lever for the table motion as in the previous construction. This gives a more strongly driven feed, and relieves the dogs of all work except that of shifting the positive clutch which controls the table feed.

The friction disk for operating the cross-feed is mounted below and just to the left of the cross-feed hand-wheel in Fig. 1. This disk plays between stops, which may be adjusted to any suitable position about the circumference of the carrier in which they are mounted, to give the desired amount of feed at each end of the stroke. The reversing plate, which is thus given a definitely limited movement at the end of the stroke, has pivoted to it a plunger having rack teeth cut in it, meshing with a pinion mounted loosely on the cross-feed

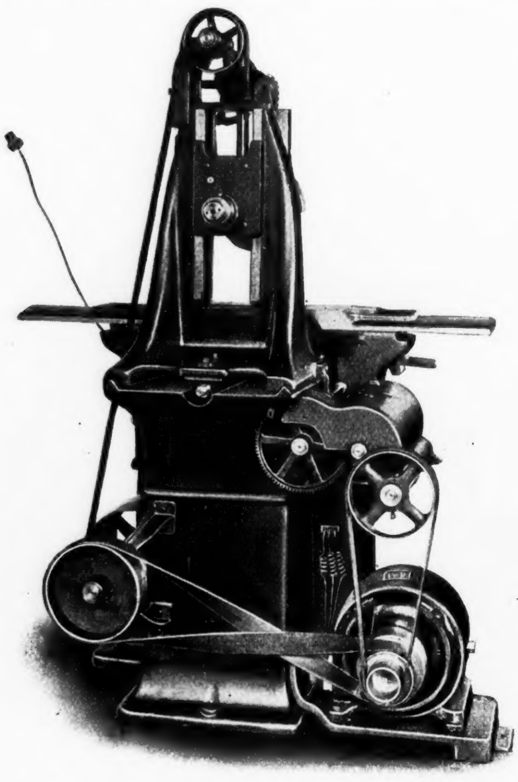


Fig. 2. Rear View of Grinder showing Wheel and Feed Driving Connections.

screw. This plunger is confined in a holder which is also loosely pivoted about the same axis. The point of attachment to the cross-feed plate is such that it may be given a movement each side of the dead center, thus giving an out and in movement to the plunger at each end of the stroke. This out and in movement is transmitted to the pinion, which in turn carries an arm with a reversible pawl engaging a ratchet wheel on the cross-feed screw. By reversing this pawl, the direction of the feed is regulated.

The machine we show is motor driven. The motor is mounted on a special base connected with the base of the machine, and fastened to the floor at its outer extremity. By this means, although one end of the motor base rests on the floor, the whole arrangement is still a self-contained unit. It will be noted that the motor is placed on the clean side of the grinder, the direction of rotation of the wheel throwing the dust and emery toward the opposite end. The motor shown is of the direct current type, but an alternating current motor will be furnished if desired. The starting box is in a convenient location at the right-hand side at the front of the machine, as shown in Fig. 1.

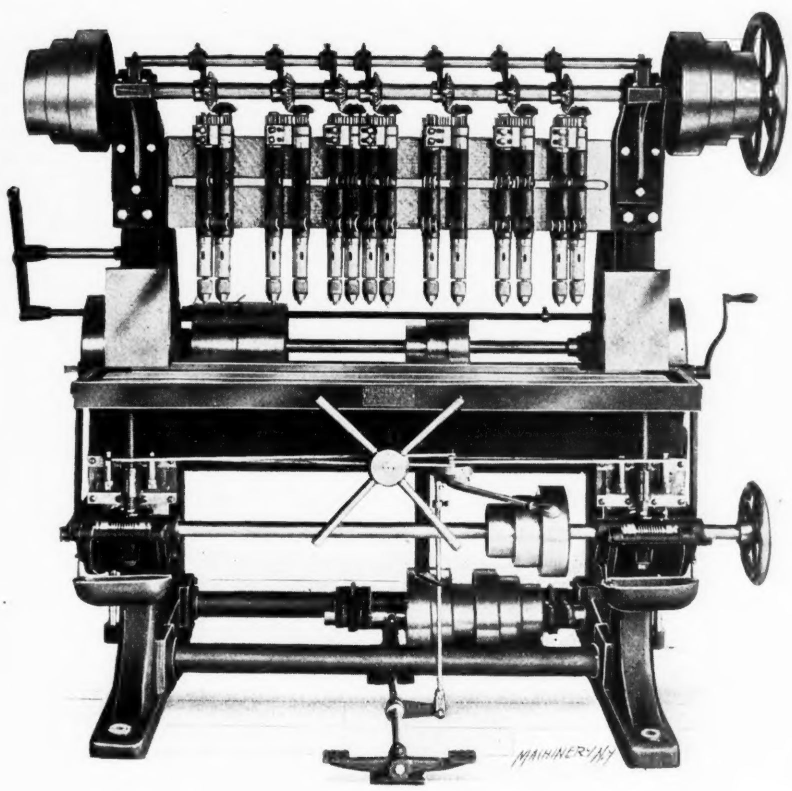
As may be seen in Fig. 2, the outer end of the armature shaft is provided with a three-step cone. Two of these steps are of considerable width for driving the emery wheel drum. The two speeds thus provided, allow for speeding up the spindle as the wheel wears to smaller diameter. The third step of the cone pulley on the armature shaft is connected with the table feed driving mechanism. A feed movement of somewhat different construction from the belt-driven type shown in our previous issue, is used with this motor-driven machine. No bevel gears are used in reversing by this movement. The shaft on which the feed driving pulley is mounted carries two pinions, one of which meshes directly with a mating gear on the reversing shaft, while the other one is connected with

a similar gear through an intermediate idler, the location of which may be understood by looking at the feed box at the left of Fig. 1. The clutch for connecting these two gears alternately with the reversing shaft on which they are loosely mounted, is of the positive instead of the friction type, as in the older design. The automatic movement in this new machine has also been improved, being so constructed that the workman can reverse the cross-feed and set the automatic stop for the return stroke without waiting for the stop to be released from the previous movement.

The machine as shown is arranged for dry grinding, but provision has been made in its design, and in the water guards and other attachments which will be furnished, to use water if desired by the purchaser. This machine will grind a length of 20 inches, a width of 8 inches, and a height of 10 inches with a full-sized wheel. The same motor arrangement shown can be applied to No. 3 machine, if desired.

IMPROVED SPINDLE ARRANGEMENT FOR ANDREW MULTIPLE DRILLING MACHINE.

We have described in this department in previous issues of MACHINERY (February, 1906, November, 1907, and April, 1908) various designs of the multiple drill built by M. L. Andrew &



Andrew Drilling Machine with Double Spindle Drive allowing Close Spacing.

Co. of Cincinnati, Ohio. These drilling machines follow the general design shown in the engraving. The frame of the machine consists of two side housings connected by suitable distance pieces and a cross rail at the top, on the latter of which the spindle heads are adjustable. The work table is supported on a screw at each end for feeding the work up to the drills. These feed screws are operated simultaneously by worm gearing, which keeps the table always horizontal, at right angles to the axis of the drill spindle. The feed screws act on double split nuts, which are simultaneously closed or opened by a single lever, thus furnishing means for throwing the power feed in or out of action. A pilot wheel is provided for raising and lowering the table by hand. Three rates of feed are furnished, and three spindle speeds. The uses of the machine are obvious, it being possible to drill a number of holes at one setting, spaced through a great variety of layouts.

The improvement illustrated in the machine herewith shown relates to a provision for decreasing the minimum distance between two adjacent spindles. In the older design, this was limited by the driving mechanism, which consists, as may be seen, of a horizontal shaft at the top of the machine, connected by bevel gears with the various spindles. These bevel gears have to be large enough to drive drills up to ½ inch in diameter, and they consequently limit the closeness with which any two adjacent heads can be spaced. The improvement consists, as shown, of driving two heads from one set of bevel gearing, by connecting the two heads with an idler gear, mounted with a swivel adjustment on the driving spindle, to correctly mesh with a spur gear on the driven spindle of the pair. As these driving spur gears take no room sidewise outside of their diameter, the spacing of the spindles is limited only by the requirements of the spindles and the heads. This improvement, in connection with the bracket arrangement for the side adjustment of the spindles for staggered holes (described in the February, 1906, issue) materially increases the range of usefulness of this machine.

ARMSTRONG QUICK-ACTION DRILL VISE.

The illustration shows a drill vise made by Armstrong Bros. Tool Co., 113 N. Francisco Avenue, Chicago, Ill. The special feature of this vise is the provision for rapidly sliding the jaws in or out to suit the work, without the necessity for using the slow screw movement for this purpose. When the jaw has been adjusted to position it may be tightened by turning the knurl handled screw shown. The vise is, of course, useful as well for many operations in the shaper or milling machine and it is provided with projecting lugs for strapping it to the table of the machine.

The movable jaw is held in alignment by a hinged clamp which fits a slot machined in it, and extends down through a similar central slot in the base. Through the upper member of this hinged clamp is threaded the tightening screw, with its knurled handle. The inner end of this tightening screw carries a ball jointed abutment (such as used for the heads of jack screws) which bears against an inclined surface on the rear of the jaw. When the screw is loose and the rear end of the handle is raised, the jaw and its contained clamp is free to slide to any desired position. The pressing down of the handle, by means of an eccentric surface formed by the upper part of the clamp, binds the latter firmly in position on the base. The turning of the screw against the jaw and the consequent tightening of the work in place, tends still further to throw the handle down and to bind the clamp still more firmly in place. It will be noticed that the screw points downward. This has the effect of pressing the sliding jaw downward and against the work instead of lifting it as is the case with vise jaws of the ordinary construction, operated by a screw in the base. By this means the work is held true and solid with one turn of the handle.

The sides of this vise are ground parallel and at right angles with the bottom so that work can be drilled from

A Drill Vise that can be Rapidly Adjusted.

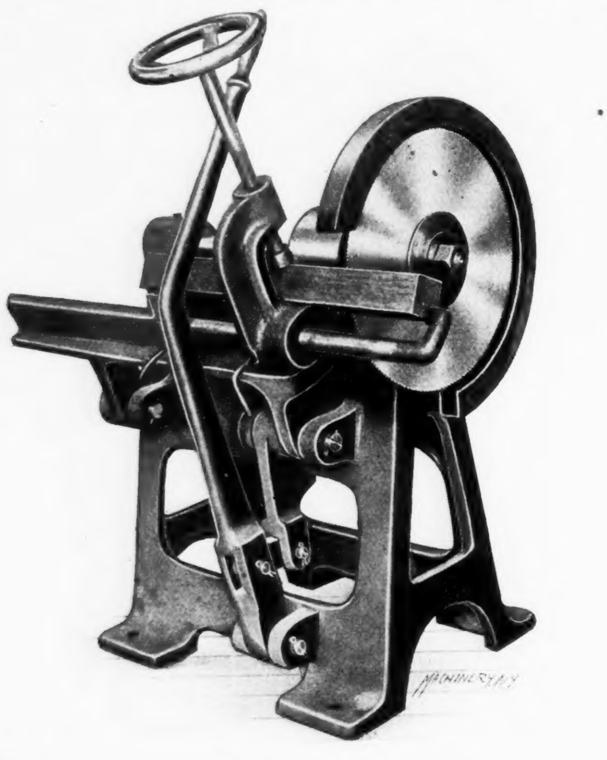
three different sides. The jaws are made of tool steel. The device is made in three sizes. No. 1 has a jaw 2 inches wide, 15/16 deep and opens 1 3/4 inch. The corresponding figures for the No. 2 vise are 2 3/4, 1 3/16, and 2 1/2 inches re-

spectively, and for the No. 3 vise 3 1/2, 1 7/16 and 3 inches respectively. These vises weigh $4\frac{1}{4}$, $8\frac{1}{2}$ and 16 pounds respectively.

THE BILLINGS & SPENCER HOT SAW.

The cold saw shown herewith has been designed by the Billings & Spencer Co. of Hartford, Conn., and is especially adapted for the work of the drop forging plant. Used as a hot saw, it is employed for the rapid cutting off of bar stock and trimming the ends of such forgings as crank-shafts, spindles, axles, etc. While designed primarily for use as a hot saw, it is capable of cutting cold stock as well, in the smaller sizes.

The carriage is swung toward the saw about a pivot, by a compound lever movement, actuated by the long hand-lever shown. This gives a rapid-acting feed, and at the same time a very powerful one. The carriage is provided with a hand-



Hot Saw Especially Adapted to the Requirements of Drop Forging Work.

wheel for clamping the work, and an adjustable stop for setting the work to length. The saw used is 20 inches in diameter and $\frac{1}{8}$ inch thick, and should run at 2,500 revolutions per minute. It is driven by a 4-inch belt. The capacity of the machine for hot sawing of steel of all kinds, is for work up to 3 inches in diameter. Cold iron or soft steel up to $1\frac{1}{2}$ inch in diameter can be handled.

LANG'S HEEL BLOCKS AND STUDS FOR SETTING UP AND HOLDING LARGE WORK.

In the September, 1905, issue of MACHINERY was published an article entitled "Importance of Good Clamping Facilities in Machining Large Work," in which was described the surprising saving of time effected on such work in the shops of the Bullock Electric Mfg. Co. of Cincinnati, Ohio, by the use of special appliances for clamping, on planers, boring mills, etc., and on the floor plate for use with portable tools. One of these appliances was a form of T-bolt head made by the G. R. Lang Co. and used with plain studs threaded at each end. These were supplied for each machine, in a box, together with a variety of clamps; this provided from 1 to 2 dozen T-heads and 3 to 12 dozen studs, ranging from 3 to 36 inches in length, supplied with suitable nuts and washers. The use of these obviated a tremendous amount of lost time in the hunting up of suitable clamping arrangements. In addition, each machine was provided with turn-buckles having forked stub ends, to be used as drivers and braces, and with cast iron heel blocks also, made in step form, so as to be adjustable for height. This latter appliance is now manufactured as a regular stock product by the G. R. Lang Co., of Meadville, Pa.

This device is shown in Fig. 1. As may be seen, the form of the blocks explains their use. They are made in two sizes, 4 and 6 inches high respectively, and can be stacked up to extend to any height from 1 inch to 3 feet if necessary.

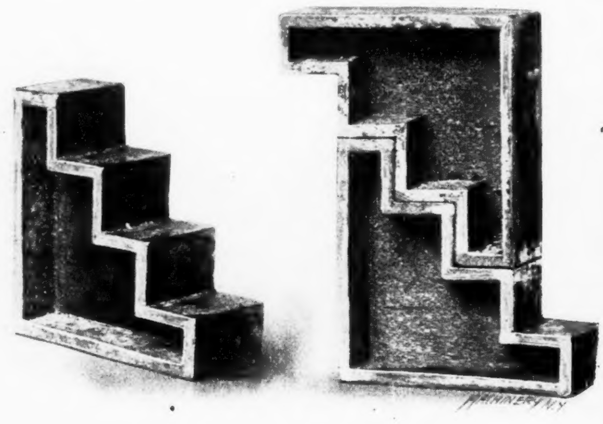


Fig. 1. Adjustable Cast Iron Stepped Blocking.

These steps are obtained in increments. The fractions of an inch can be taken care of by using small pieces of flat iron and washers between the steps and the ends of the clamp. These blocks are cast from accurately machined metal patterns which produce good flat surfaces, and thus give a solid bearing support to the clamp. In addition to their other conveniences, they have that of stability. It is not always possible to leave work from Saturday night to Monday morning without it becoming loosened, especially if wood blocking is used.

In Fig. 2 is shown a modification of the bolt head mentioned in the former article. These heads are made of a good quality of steel, and are carefully machined to fit the slots they are to be used in. They are especially adapted to places where the maker's T-bolt heads would interfere with the work—in such cases, for instance, as bolting chuck jaws to a boring mill table, and other similar short work. They may also be used on old machines where T-slots have been badly broken out by the use of poorly fitting bolts, and where a good machine fit is required to hold. Standard sizes are kept in stock, but special sizes will be furnished when the dimensions of the T-slots they are to fit are given by the customer. The use of the studs with these, in place of the ordinary T-bolts, gives the same advantages as with the builder's previous form of bolt head. It is not only cheaper to fit the machine with these than with forged bolts, but it costs less to keep them in shape. The studs are made of steel and hardened, and will greatly outwear the ordinary bolt, which wears out on the upper threads and becomes useless for the greater part of its length. The square head shown in Fig. 2 is not tapped entirely through. It is thus possible to make them into permanent bolts by simply screwing studs down tightly into them, where they will stay until removed with a wrench.

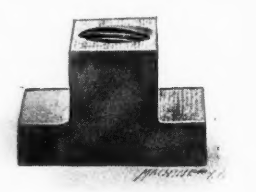


Fig. 2. Machined Steel Tee-head.

CINCINNATI TWO-SPEED PLANER DRIVE.

What seems to be the limit of simplicity in the construction and operation of a two-speed planer drive, has been designed by the Cincinnati Planer Co. of Cincinnati, Ohio. This arrangement is shown applied to a standard planer in Fig. 1. The only change in the construction of the machine is the addition of a second tight pulley on the driving shaft, and a provision for a second speed in the counter-shaft, as shown in Fig. 2. This gives two forward speeds with constant reverse at high speed, without manipulation of the counter-

shaft belt shifters, the only change being the shifting of a plug in one of the belt forks in the reversing.

Fig. 2 shows the arrangement of the pulleys on the counter-shaft and on the driving shaft of the machine. With the exception of loose pulleys A and B, the arrangement of this

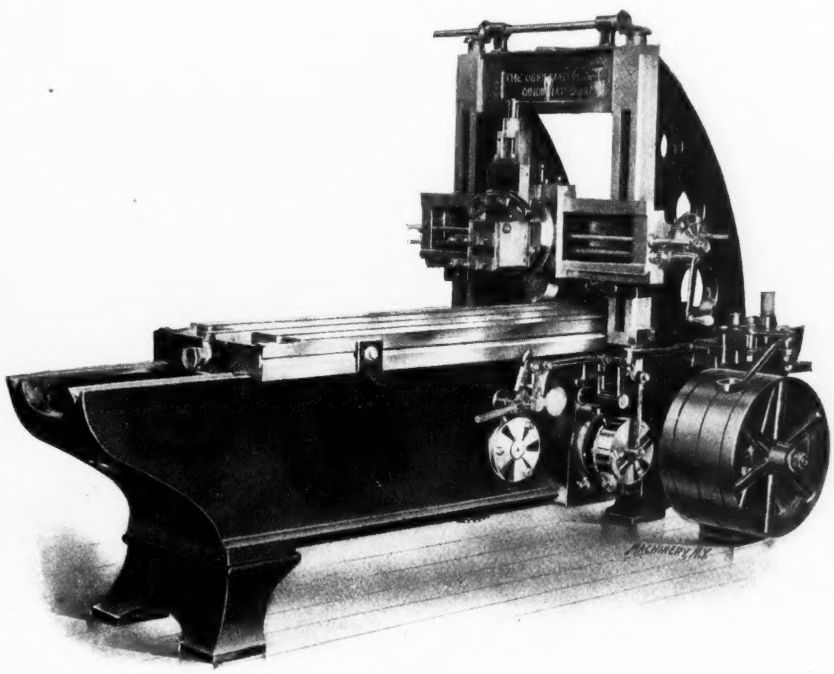


Fig. 1. Cincinnati Planer with Modified Belt-shifting and Driving Pulley Arrangement for Two-speed Drive.

counter-shaft is unchanged. The regular driving pulley C has a speed, as will be noticed, of 400 revolutions per minute, for a cutting speed of 50 feet per minute. This pulley is keyed to the shaft and drives the usual forward driving pulley D and the reversing pulley E, the latter of which, it will be noticed, has a heavy balance rim. On the driving shaft of the machine the forward belt is shifted from loose pulley F to pulley G for the cutting stroke, being returned to F for the reverse, which is effected by shifting the backing belt from loose pulley H to driving pulley G. This is, of course, the usual arrangement. In addition to the belt from the main line to the loose pulley K on the counter-shaft, there is

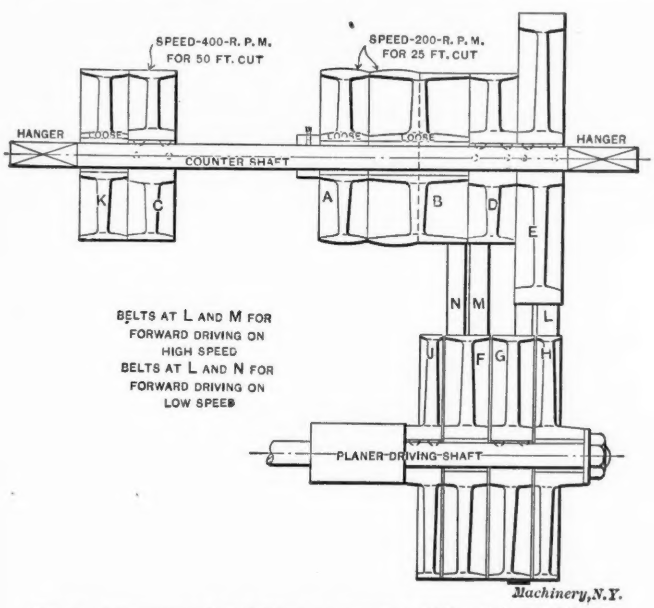
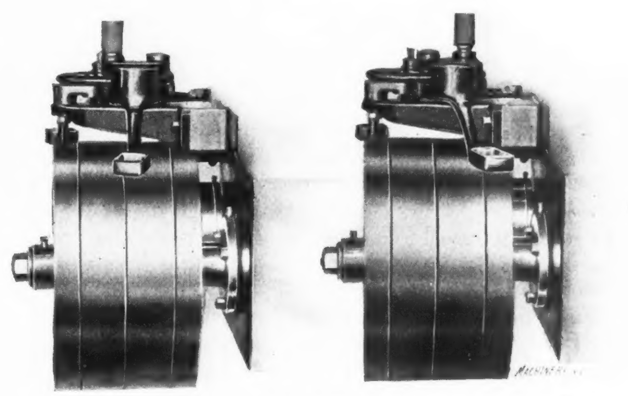


Fig. 2. Arrangement of Pulleys on Counter-shaft and Driving Shaft.

a second one running at half the speed which drives loose pulley B on its left-hand side, at 200 revolutions per minute. By a change in the reversing mechanism of the planer, the forward motion belt instead of playing between G and F and being driven by a pulley D, may be shifted to play between tight pulley J and loose pulley F, and be driven at a reduced speed by pulley B, giving a forward cutting speed of 25 feet per minute.

This change in the position and direction of shifting of the forward cutting belt, is effected by changing the connection between the reversing cam and the forward belt shifter. Figs. 3 and 4 show the two positions of this apparatus. In Fig. 3 the knurl handled plug shown, passes down through its seat in the belt lever into the slot in the reversing cam, which thus actuates the belts in the usual way. By shifting this plug to the position shown in Fig. 4, on the opposite side of the fulcrum of the shifting lever, the direction of movement of the shifting is reversed, and the position of the belt is changed so that it operates on pulley B in Fig. 2 instead of on pulley D, giving the reduced cutting speeds.

Only one belt shifter is required for the counter-shaft, as this provides for simultaneously shifting the belt onto and from loose pulleys A and K, so that no more movements are required for the counter-shaft operation than with the usual simple arrangement. It will be noticed that the loose, slow-cutting pulley B revolves on the shaft only the difference in speed of the two drivers B and C, so that the service is not severe. The loose pulleys on the counter-shaft are arranged with special bronze bushings which allow room for a large reservoir of oil in the center. Slots on opposite sides lead from this central reservoir to the shaft and are so disposed as to cover practically the entire bearing surface. These slots are filled with felt which gradually draws the oil by capillary attraction to the journal. These pulleys, arranged in this way, need oiling only two or three times a year.



Figs. 3 and 4. Position of the Driving Belt Shifter Plug for Fast and Slow Drive.

The machine to which this drive is shown attached in Fig. 1, is one of the builder's regular 24 x 24-inch planers. It will be seen that very little change has been made in its design, the alterations being confined to the reversing mechanism, and the addition of an extra driving pulley.

PEERLESS HIGH-SPEED REAMERS.

The Cleveland Twist Drill Co., Cleveland, Ohio, is making a new form of reamer with high-speed steel cutting edges and carbon steel bodies and shanks, united into a solid, inseparable unit. The high-speed blades only are hardened, so that while the tools have all the hardness and cutting qualities of solid high-speed tools, they are at the same time less brittle than reamers made entirely of carbon steel. This special construction allows these tools to be marketed at a price very much below that of ordinary high-speed reamers. The process of fitting the high-speed steel blades into and solidly joining them to soft steel bodies, is done by a process termed "brazo-hardening," which has been developed and patented by the builders.

These tools are made in a number of styles, of which three are shown in the accompanying engravings. Fig. 1 shows a solid reamer of the kind largely used in screw machine work. The inserted high-speed blades are plainly seen in the engraving. Fig. 2 is a tapered shank expansion chucking reamer, in which the variation of size is obtained by screwing in or out a taper plug seated in a taper hole in the end of the reamer. The end of the reamer is split to allow the blades

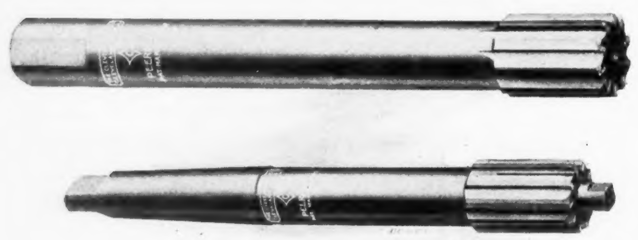


Fig. 1. Solid Roughing Reamer with Brazed Blades of High-speed Steel.
Fig. 2. Expansible Reamer with Blades similar to Fig. 1.

to spread or contract as the plug is screwed out and in. Shell reamers also are made on this expansion plan, as shown in Fig. 3, though in this case the threaded and tapered member which spreads the split ends of the reamer, is a bushing instead of a plug. This bushing is turned for adjustment by means of a keyed plug inserted in it, with a head flatted

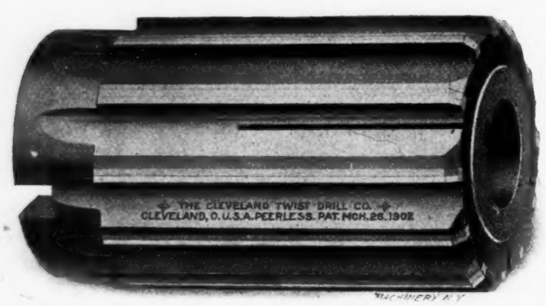


Fig. 3. Expansion Shell Reamer with Brazed-in Blades of High-speed Steel.

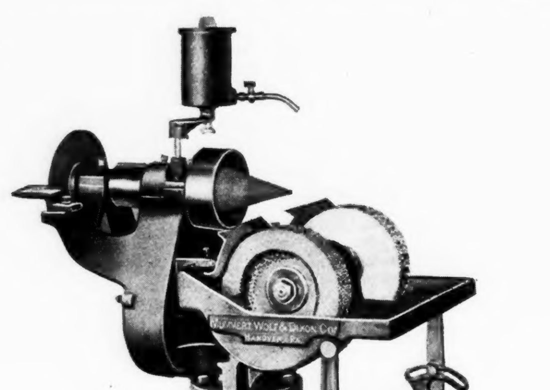
for a wrench. The advantage of the expansion reamer of this form is that it may be kept up to size at the point where it is most subject to wear. Besides this, the amount of longitudinal clearance is varied according to the material to be cut, so that jamming in the hole is prevented. This results from the fact that it is necessary to expand a reamer more to get a given size in soft metals than in hard metals, and this greater expansion gives the greater longitudinal clearance required. Owing to the process of using a soft body, and a hard cutting edge, the Peerless expansion reamers will stand much more expansion than the carbon steel reamers of similar design, and the builders state that they are the only expansion reamers which have as many cutting edges as the corresponding size of the solid type. Their price is about the same as that of the ordinary solid high-speed reamer.

COMBINATION REVOLVING OIL-STONE AND GRINDER FOR GENERAL EDGE TOOL SHARPENING.

We have described in previous issues of MACHINERY (see New Machinery and Tools for June, 1907, and April, 1908) two forms of the edge tool sharpening machine built by Mummert, Wolf & Dixon Co., Hanover, Pa., in which the sharpening is done by a revolving oil-stone wheel in place of an emery wheel or grindstone. It is stated that tools may be ground in this way with the same effectiveness as by hand on the oil-stone, but in a great deal shorter time. The latest development in this idea is shown in the accompanying engraving, which represents a machine made by the same builders, and provided with all the various wheels necessary for keeping wood-working and patternshop tools up to a high degree of efficiency.

As may be seen, two wheel spindles are provided, of which the upper one, running at a high-speed, is provided with an ordinary emery wheel, a leather stropping wheel, and an emery cone. The lower one carries two oil-stones, one of fine grain and the other of coarser texture. The machine is driven from the upper high-speed spindle by a 2-inch belt on the 3-inch diameter driving pulley shown. This spindle is connected to enclosed spur and spiral gearing which reduces the speed of the grinding shaft (which should be about 1,800 revolutions per minute) down to 260 revolutions per minute for the oil-stones' spindle. These stones run in a dished tray, which is provided for catching the kerosene oil with which they are supplied. After the stones have once been filled with this oil, but a small amount is required daily to keep them in condition. The oil is provided by the closed oil pot shown above the cone wheel, mounted on hinges so that it may be moved out of the way when working on the upper spindle. The use of kerosene keeps the wheels clean and sharp, and prevents glazing. The wheels readily absorb the oil, and when not running appear to be dry. As soon as they are rotated at the proper speed, the oil is brought to the surface by centrifugal force. The adhesion of the oil to the stone prevents it from falling off, though oil guards are provided to keep it from flying in the case there is any loose oil in the pan below the wheel.

The outfit of wheels provided, as mentioned, covers practically the full range of tools used in the wood-working shop or pattern-shop. The grinding cone is useful for sharpening pattern-maker's gouges having inside bevels. It is conveniently placed where it can be used without interference between the tools and the oil-stones. The leather wheel, which is mounted on the large diameter of the cone, is for stropping the tools after grinding. The edge of the leather on one side of the wheel projects outward, making it possible to strop inside bevels. The periphery of the wheel is used for flat tools such as chisels, plane bits, etc. The regular



A New Design of the Mummert, Wolf & Dixon Oil-stone Tool Sharpener.

grinding wheel at the back of the spindle may be conveniently used with a narrow wheel 8 or 10 inches in diameter for gumming saws, grinding molding bits, etc.

Two grades of oil-stones are provided, as described, one of comparatively coarse grain for rapidly bringing the grinding edge into shape, while the other has a very fine grain and puts on a keen, smooth edge. If the workman desires he may make use of the tool holding attachment shown, for grinding plane bits, chisels and other tools having straight edges. It may be swung up into position and set for any desired angle

of cutting edge. The blade is clamped in the holder and shifted back and forth across the face of the wheel. When not in use, it is left hanging downward where it is out of the way of the operator.

The machine is shown arranged for counter-shaft drive. The counter-shaft may be placed either on the ceiling or beneath the floor, the position of the pulley making this possible. For motor drive a different form of pedestal is provided, to which the motor is attached. This is belted direct to the pulley on the upper arbor, making a very compact arrangement.

LINDHOLM ROTARY CENTER TEST INDICATOR.

The centering of prick-punch marks, jig buttons and similar reference points in fine machining, tool-making, etc., has always been a painstaking and time consuming operation. When doing this work on the face-plate of a lathe, the operation is much simpler as it is possible to apply a test indicator to the prick-punch mark or button, and center the work easily and quickly. So far as we know, the notion of making a test indicator which would do this when the work is stationary and the spindle revolves, has not occurred to anyone before the invention of the device we show herewith. If it has occurred, the arrangement has at least never been put on the market.

Description of the Instrument.

The indicator for this purpose here described, is made by Lindholm & Dennis, New Haven, Conn. Fig. 1 shows an exterior view of the device, while the construction is more plainly seen in the line drawing, Fig. 4. The instrument is mounted on a shank *B*, of any suitable form to be held in the spindle of the milling machine, drill press, or other machine in which the work is to be done. This has firmly screwed to it a body or frame *A*, which carries the indicating point and the multiplying mechanism. The indicating point *E* is mounted on a stem *C*, which is supported in turn in a ball joint formed in the body *A* by its spherical end, and the spherical seats in the two set screws shown. When the work is set so that the point of *E* enters the prick-punch mark or the center hole of the jig button and is pressed lightly in place by the spring supporting it, the revolving of the machine spindle in which the instrument is set, causes the stem *C* to "wobble" with reference to the body of the instrument if the axis of rotation of the spindle is not in alignment with the reference point in the work. If it is in line with the axis of rotation, the stem runs as true with the instrument as if it were solid with the body *A*. The "wobble" which takes place if the work is not lined up with the spindle, is transmitted through arm *J* (which is fast to stem *C*) through levers *K* and *L*, to the fine wire attached to the long end of the latter. This wire passes through a hole in the shank of stem *C*, where it is attached to the end of a stirrup *G*. This stirrup passes through slots in the sides of the stem, and engages thimble *D* sliding on the outside surface of *C*, where it moves up and down under the influence of the stem itself, as the spindle is revolved, this movement being multiplied by the levers just described. Spring *H* keeps the stirrup and thimble normally at their lowest position, and furnishes the resistance against which the movement of the stem is transmitted through the lever mechanism.

The movement of the thimble on the shank is read by a series of graduations in the periphery of the latter. These graduations, which are 1/32 inch apart, represent thousandths of an inch of eccentricity. Of course, the advantage of having the indicating done by this thimble instead of by a pointer moving over a dial, is that the readings can be taken while the instrument is rotating. This would not be the case with a dial, as the workman would have to take readings in different positions of the spindle, stopping the latter and following it around to the indicating point for each reading. As will be shown later, it is very important that readings be taken while the spindle is revolving.

While the uses of this instrument would seem so obvious as to need scarcely any description, a number of interesting results have been observed in practical use. The device was invented a number of years ago, and has been used in at least two large establishments where the finest kind of tool-making is done, and the makers state that in these plants it has revolutionized methods in jig making, and has proved to be a great time saver and cost reducer in the tool-making department.

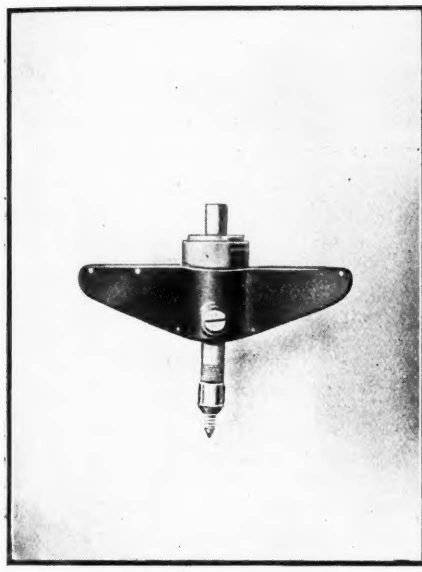


Fig. 1. The Lindholm Rotary Center Test Indicator.

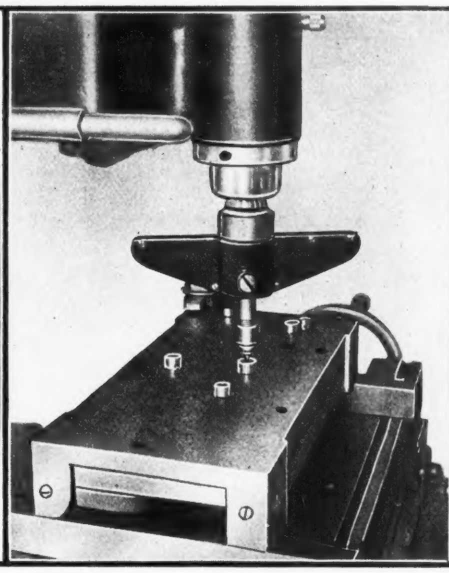


Fig. 2. Indicating the Concentricity of a Jig Button with the Spindle.

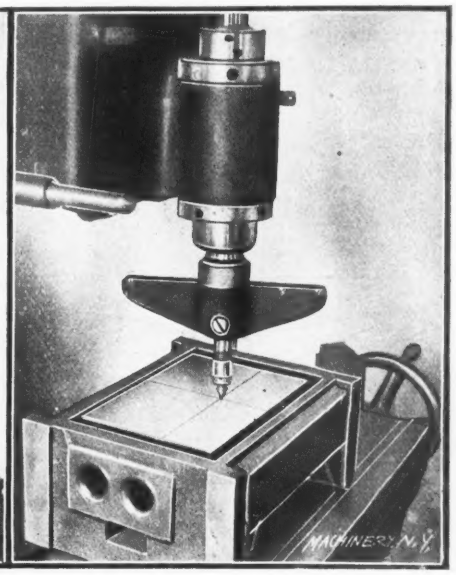


Fig. 3. Centering a Prick Punch Mark with the Spindle.

Uses in Tool-making and other Fine Machine Work.

In tool-making it is well known that the greater part of the time on a job is consumed in getting ready and setting up; this is noticeable, for instance, in setting a jig or fixture on a face-plate or lathe, by indicating a prick-punch mark or button centrally with the spindle. It is not necessary to explain the maneuvers gone through in strapping and clamping the work properly, balancing the face-plate, and then knocking the work back and forth to get the button or prick-punch mark central. The time required for all this on fine work runs up into the hours on even simple fixtures. The use of master plate or micrometer methods does not effect a saving of time when used in connection with the lathe, as the same preliminaries must be gone through. In handling work of such dimensions and shapes that it would be impractical to use the lathe, the milling machine is used, but this does not reduce the time expended, no matter what the method used. Accuracy is difficult, also, when using the method of locating the points by the graduations on screws, or by trying to split thousandths of an inch in vernier readings. To overcome this uncertainty, obtain accurate results,

and reduce the time employed to the minimum, this rotary indicator was designed.

The instrument is inserted in the spindle of the machine used, the pointer of the indicator is placed in the prick-punch mark or button on the work, and the exact location of the center of the button or prick-punch mark with reference to the axis of rotation of the spindle is seen at once on starting the machine. Adjusting the work so that it becomes central requires but a fraction of a minute. Releasing the indicator and inserting the boring tool requires but a short time more, and the machining operation is at once commenced.

It has been found by the use of this instrument that the same speed should be used when indicating the work as is employed when boring the hole, thereby insuring the same conditions of the machine in relation to the work when boring as when indicating. An instrument was tried on a vertical milling machine to determine the accuracy of the spindle and the table in relation to each other when the machine had been running for a certain length of time in one case, and when allowed to stand for an hour in the second case. After the machine had been running for some time it was stopped and a jig with a button placed on the table and the pointer of the indicator placed in the button, which was then indicated centrally with the spindle. The machine was next stopped for an hour, the indicator remaining in place in the button. The machine again being started, the spindle was shown to be out of center with the work by 0.0005 inch. Allowing the machine to run brought the spindle back to its

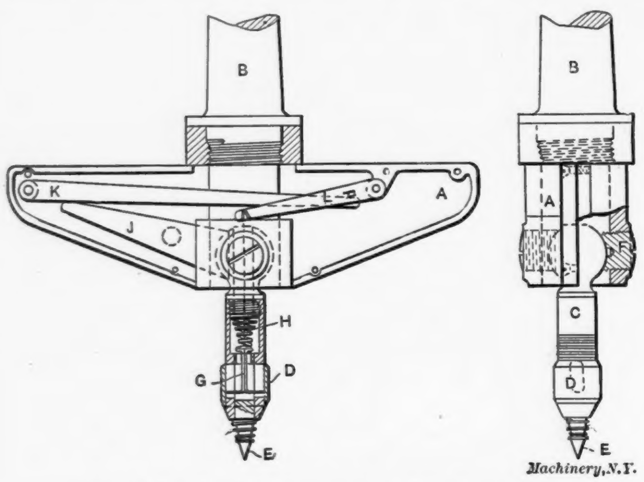


Fig. 4. Details of the Construction of the Instrument.

former position. The time required for this was about ten minutes. This experiment was tried a number of times, and proved that the condition of the spindle in relation to the work should be taken into consideration when doing accurate work. [This was doubtless due in part to temperature changes, but perhaps more to the distribution of the oil over the surface of the journal, which is different in running conditions than when the spindle is standing still.—EDITOR.]

Another experiment was tried to determine what effect a light blow would have on the table. A lead hammer was used, striking very light blows. This was found to alter the setting from 0.0025 to 0.0005 inch, showing that a slight jar would have a tendency to change conditions. All clamps and stops were securely fastened during this test.

In Fig. 2 is shown a jig with the buttons in place, located on the table of the milling machine. The point of the rotary indicator is placed in the button and the machine started. The indicator revolves with the spindle, and the thimble moves up and down showing just how much the button is out of center with the spindle. The table is then adjusted until the thimble is at a stand-still. The time required need not be more than 20 seconds. The instrument is removed and a boring tool inserted, the same speed being used as when indicating. In Fig. 3 the same vertical milling machine is shown, but instead of using a button, a small prick-punch mark has been made at the intersection of two lines, and the point is placed directly in this. The time required to indicate is about the same as for the button, and the accuracy of the operation depends entirely on the question of the accuracy of the tool-maker in placing the prick-punch mark. The indicator will locate the latter exactly in line with the spindle. Fig. 5 shows the rotary indicator in place in the horizontal milling machine. Here the instrument revolves about the horizontal axis and the thimble oscillates to and fro.

The device can, of course, be used on other tools—on the drill press, for instance, with the indicator in the spindle and the pointer in a prick-punch mark. In this case the work is done under somewhat the same difficulties as in the lathe—that is, a hammer or mallet must be used to bring

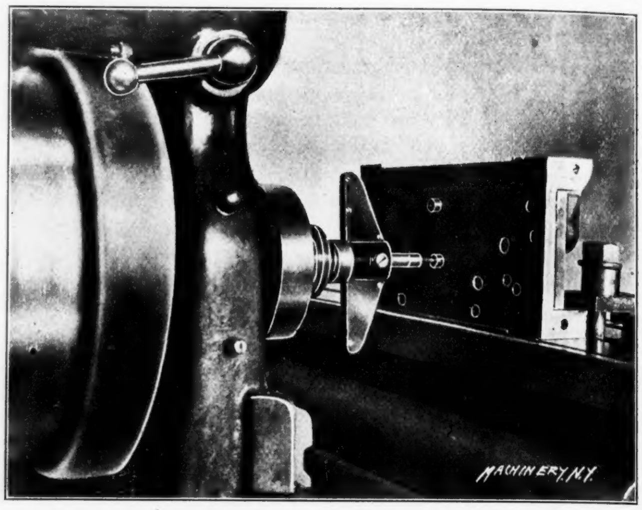


Fig. 5. Use of the Indicator in the Horizontal Milling Machine.

the work central. The indicator can be used in the lathe tail-stock as well as in the spindle. It will be noted that any form of shank convenient can be used for this instrument. Figs. 2, 3, and 5 show a straight shank screwed into the body of the instrument, which is held by a collet in the spindle of the machine; Figs. 1 and 4 show a taper shank.

HIGH-FRAME WHITNEY POLISHING JACK.

In the department of "New Machinery and Tools" of the March, 1907, issue of MACHINERY, was illustrated the Whitney polishing jack, built by the New Britain Machine Co., of New Britain, Conn. The essential feature of this jack was that it was designed to be belted from below, the belt passing through the frame and through the floor, to the line shafting on the ceiling of the floor below. No counter-shaft was required, the machine being arranged for starting and stopping by raising and lowering the spindle, and thus tightening or releasing the belt. This arrangement makes a machine which may be handled by even female help with ease and safety. So far as the operation of the machine is concerned, there is also a great advantage in belting downward, as the pressure is taken against a solid bearing instead of upward against a box cap. This gives a steady running spindle.

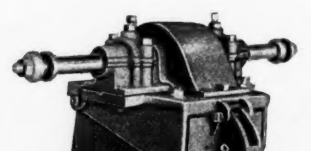


Fig. 1. Whitney High-frame Polishing Jack, made by New Britain Machine Co.

The new Whitney "high" polishing jack shown herewith, may be used with the operator standing, or seated on a high stool. The starting and stopping of the spindle is done by means of the toggle lever shown at the front; raising it lowers the hinged plate on which the spindle boxes are mounted, and thus loosens the belt, at the same time bringing the pulley down against a brake block and stopping it at once. This

relaxes the belt as well, greatly lengthening its life. By the use of this brake, a heavy emery wheel 14 inches in diameter by 2 inches wide can be stopped from full speed in three

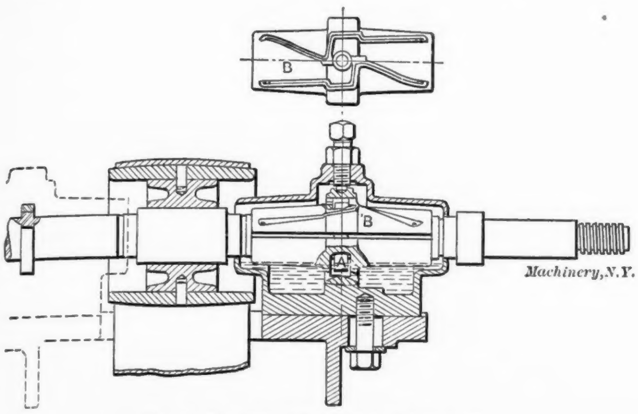


Fig. 2. Design of Spindle and Bearings.

seconds. The pressing down of the lever raises the arbor again and tightens the belt into working tension. The lever and the attached link passes by the dead center enough to lock it in position. There is no possibility (as there is with a shifter) of having the belt run off and of being obliged to start slowly on this account. There is, in fact, very little to accelerate on this machine, so that the starting is done in a very short space of time. An ordinary leather-covered wooden polishing wheel, of course, requires less time. Where frequent changes of wheels are to be made, as is quite necessary in the general run of polishing work, this question of quick stopping is an important one.

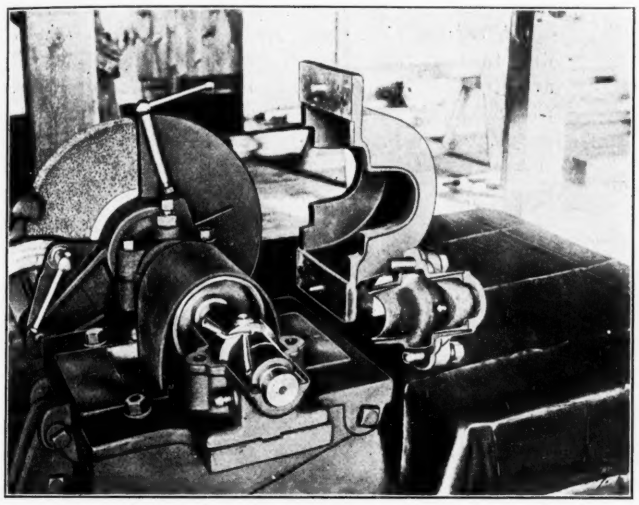


Fig. 3. Belt-cover, Bearing Cap, and Upper Half of Box removed.

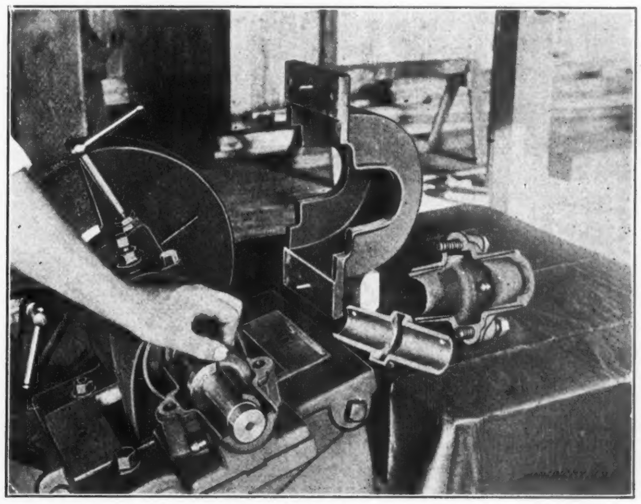


Fig. 4. Removing the Lower Half of Box.

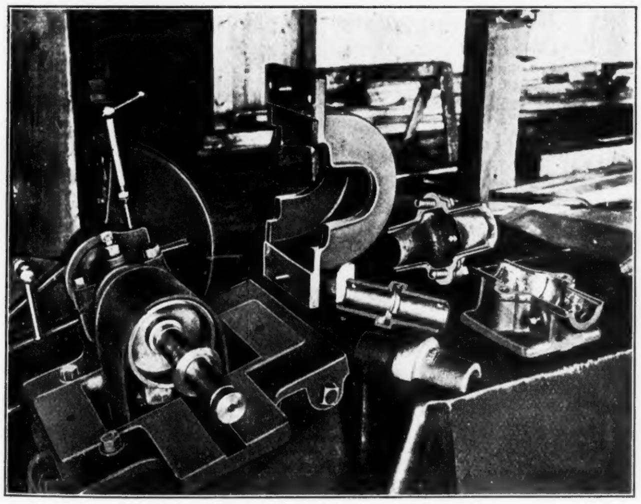


Fig. 5. Removing the Outer Bearing.

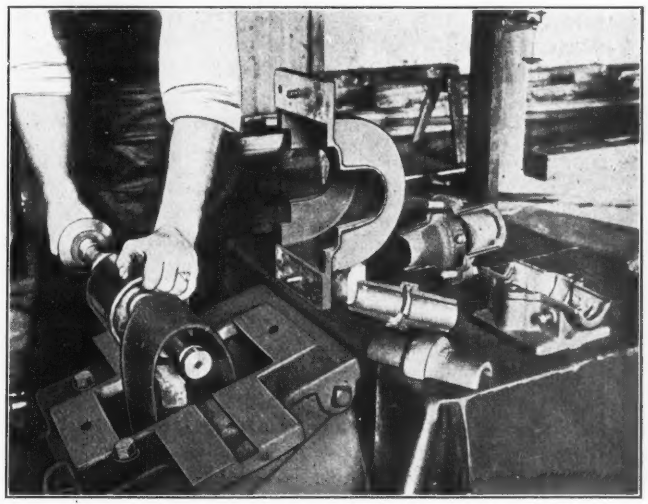


Fig 6. Removing the Spindle.

The line drawing, Fig. 2, and the views in Figs. 3 to 6, which show the dismantling of the head, illustrate the oiling arrangements. The bearings are made in halves, as shown, with a central recess in which is confined a collar *A*, solid with the shaft. These collars take up the end thrust. They run in a reservoir of oil which is conveyed to the top of the upper box *B*, where it escapes through the horizontal openings at one side or the other, depending on which side of the shoulder is receiving the thrust. From whichever side of the collar the oil is delivered, it is led by ducts, as shown, to oil holes at each end of the bearing. By cutting open the casing of the bearing, it has been found that the oil ways and oil holes are entirely full immediately on the starting of the spindle, and the flow continues without intermission as long as the spindle runs. No more than the proper amount of oil can be gotten into the reservoir, as the self-sealing oil covers are situated at the proper height to receive and hold a definite amount. The end thrust collars being located inside the box, have their oil throwing tendency thus put to good instead of evil uses. The spindle may be run in either direction, the only change necessary being to turn the tops of the boxes around so that the arrows cast thereon will point in the direction of the desired rotation. The shafts are ground and the boxes are made of gray iron. This, with the copious lubrication provided, gives a glazed bearing of a kind that is very durable. The bearing, as may be seen plainly in Fig. 2, is self-aligning, and accommodates itself to any possible spring or vibration at the high speeds prevalent in polishing practice.

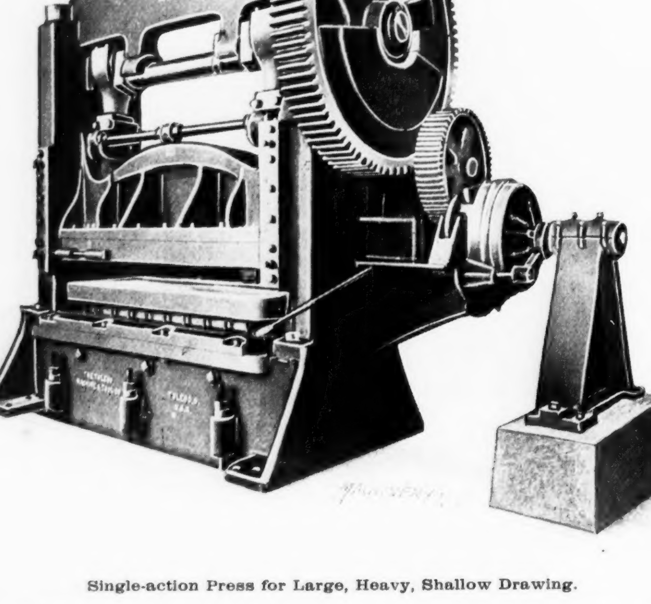
Figs. 3 to 6, which show the successive operations in dismantling the head, give a good idea of its construction. The removal of two bolts in the cap, as shown in Fig. 3, permits the latter to be removed and allows the upper half of the box to be picked off from the shaft. The lower half of the box may be tipped around and pulled out from the under side, as shown in Fig. 4. The bearing pedestal may now be slid out endwise on one side (see Fig. 5), and the whole spindle, bearing box, and wheel frame removed from the other

side. All this is done, as may be seen in Fig. 6, without removing the belt, which is then enough slackened to permit relacing.

It might be mentioned in connection with this design of frame that the insurance requirements are fully met, as in the case of fire there is nothing to burn and there is really no communication between the floors through the belt holes, as the joint between the base and the floor prevents the water from passing downward, or fire from working upward. It is not necessary to have the line shaft on the floor below, as a low platform may be built to contain it and the form of hanger used that allows the driving pulley to revolve partly in the frame of the machine. This will call for but little rise above the general floor level.

TOLEDO HEAVY SINGLE-ACTION DRAWING PRESS.

The press shown herewith, built by the Toledo Machine and Tool Co., Toledo, O., is designed for very heavy drawing, on work of comparatively shallow form, having been originally designed for making seamless casket covers. It is applicable,



Single-action Press for Large, Heavy, Shallow Drawing.

of course, to any work of a similar nature. The operation consists in first placing a plain flat piece in position on the dies. The press is started by the friction clutch shown, and the descending of the ram, at a single stroke, clamps the work and draws it to the desired form. The resulting blanks are practically free from wrinkles and buckles.

The pressure ring shown in the illustration rests on studs or pins around the exterior of the lower die. On this ring the flat sheet is placed. As the ram comes down and strikes the work laid on top of the pressure ring, the latter is carried down against the pressure of the studs or pins, which are supported by a heavy spring arrangement in the interior of the press bed. The tension on this ring is adjustable by means of six studs mounted on the outside of the base, three of which show in the illustration. These serve to adjust the spring pressure from the outside, it being thus unnecessary for the operator to get down under the press bed. A special foundation has to be provided for the machine, so constructed as to provide a pit under the press for the attachments, and for that portion of the bed which projects below the floor line.

Two men only are required to operate the machine—one operator and a helper. It is stated that the placing of the work in the press, the forming of the shape, and the removal of the finished work can be completed in ten seconds. A desirable feature of this die is the fact that it is made adjustable for a number of lengths of covers or tops, without removing either the upper or lower members from the machine. This is particularly advantageous on work of this kind, owing to the enormous size and weight of the parts.

The complete weight of the press is about 85,000 pounds. It takes in 102 inches between uprights and has a table 52 inches wide from front to back. The stroke is 12 inches. With stroke and adjustment up, the distance from the bed to the bottom of the slide is 27 inches.

NORTHERN TYPE "S" VARIABLE SPEED MOTOR.

The direct driving of machine tools by electric motors has developed in the past few years to such an extent as to result in a radical development in motor design, to meet the requirements of this work. Prominent among these requirements is that of variable speed, which is advisable to avoid complicated mechanical construction, and which is also used in connection with the mechanical changes for giving finer gradations of speed. There are well-known difficulties met in connection with the attempt to build a variable speed motor, even with the design in which the variation is obtained by inserting resistance in a shunt field circuit. The chief difficulty is the sparking met with at the extremes of the speed changes, particularly at the highest speed, when the field has been weakened. This sparking is due to the distortion of the magnetic field by the armature reaction, which increases the voltage between the adjacent bars of the commutator as they pass under the brush. The particular point of improvement in this new type "S" motor is the construction of the magnet core, which greatly reduces this distortion of the field, permitting a wide variation without any trouble at the commutator.

Fig. 1 shows the motor as a whole, while Fig. 2 shows the peculiar construction of the field. Each pole, it will be seen, is made in two parts with an air gap between. The whole field itself is built up of punchings of the shape shown. When the field is weakened and the effect of the armature reaction is therefore at its greatest, there is very little shifting of the field, owing to the reluctance of the air gap between the two sides of the pole pieces, which effectually prevents one stream of magnetic force lines from passing over into the path of the other. The lines thus travel nearly straight to the pole faces, at an even density, where the small inwardly projecting tips permit them to expand and distribute themselves fully over the entire air gap. The magnetic circuit from pole to pole is shown in Fig. 2. It should be particularly noticed that while the pole pieces are in halves, the magnetic circuit in each quarter is complete, without joints, as each one includes in itself a north and south pole.

This arrangement of the magnetic circuit lends itself readily to effective and simple mechanical construction, as it is

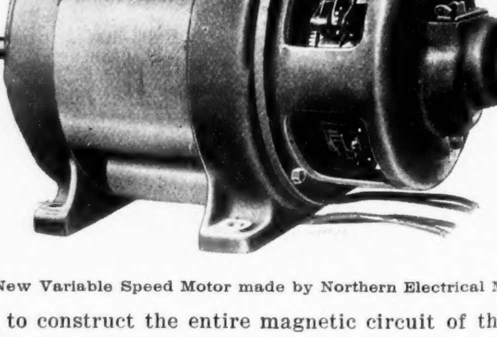


Fig. 1. New Variable Speed Motor made by Northern Electrical Mfg. Co.

possible to construct the entire magnetic circuit of the motor from soft sheet steel stampings. This increases the magnetic efficiency, as all joints are eliminated, and the possibilities of blow-holes and other defects are avoided. For this reason, therefore, less section is required, with a consequent reduction in weight, while the material used is of the kind

best adapted to respond quickly to changes in full strength, owing to its low hysteresis. The laminated construction also prevents any eddy currents from being set up in the pole faces. All of these points are especially desirable in a motor for use in variable speed work. The construction, in addition, lends itself readily to special ratings, as the length of the machine can be so increased as to span the gap in ratings between successive frames, as it is simply necessary to stack up the proper width of armature and field punchings to give a motor of the size required. Before being finally secured

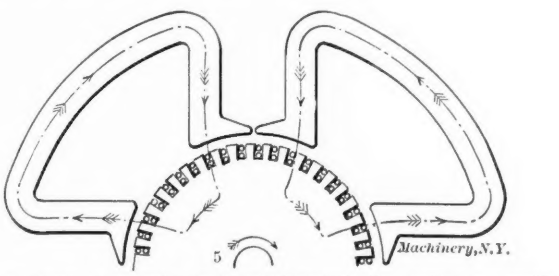


Fig. 2. Diagram showing Split Field Magnet Core which prevents Field Distortion.

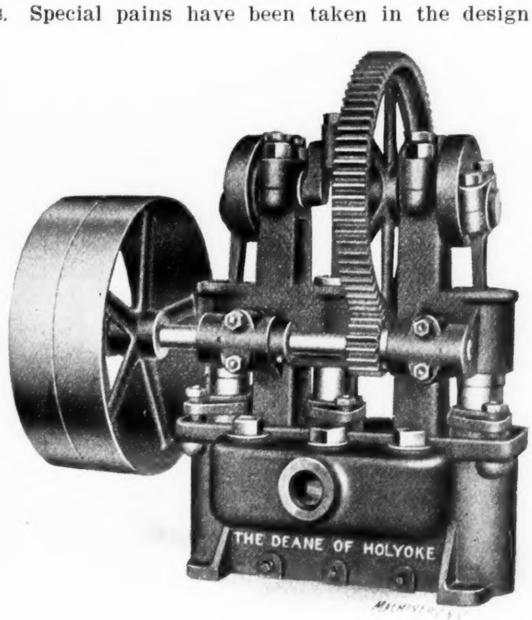
together, the whole mass is placed under hydraulic pressure and compressed, where it is held rigid while the retaining rivets are set. The end flanges are machined and tapped for the bearing frames.

The armature is of the characteristic type made by this firm. It is wound with machine formed coils and has a commutator of hard drawn copper bars. A box type brush holder is used, with easy means of adjusting the tension on the brush and for removing it for inspection. The bearings are of the self-aligning type. The motor will be furnished in the enclosed form when desired. It is especially efficient under these conditions, as the laminated construction reduces the eddy-current heating to a minimum, and the nature and extent of the exposed surface are such as to greatly assist in the dissipation of the heat generated by the internal resistance.

These motors are built by the Northern Electrical Mfg. Co., Madison, Wis. They are made in sizes up to 50 horse-power, under constant speed, with a wide range of adjustable speed ratings up to 6 to 1 in regular designs, and with even larger ratios under special conditions.

DEANE TRIPLEX POWER PUMP.

The accompanying illustration shows a power triplex pump put on the market by the Deane Steam Pump Co., of Holyoke, Mass. Special pains have been taken in the design of this



Deane Triplex Power Pump.

machine to make it simple, compact and rigid, and particularly to make it entirely accessible for inspection and adjustment in all its parts. The crank and pinion shaft bearings and the connecting-rod bearings are adjustable for wear. The crank-shaft and connecting-rods are drop forged. The stuffing boxes, which are unusually deep, are of the stud gland type. The design of the frame is such as to afford an unusual amount of room for repacking the plungers, which, it will be seen, is done from the outside. Each valve is separately accessible through a quickly-removed hand-hole cover. The valves are of rubber or bronze, depending on the service for which the pump is required. A drip flange is carried all around the pump at the top of the water cylinders to catch leakage from the plungers, and any oil which may run down over the frames from the working parts. The machine is supplied regularly with tight and loose pulleys, as shown, but may be fitted with double gearing and a special base for direct connection to a motor, at a slight additional cost.

UNION GEARED DRILL CHUCK.

The accompanying engraving shows a geared drill chuck which has just been placed on the market by the Union Manufacturing Co. of New Britain, Conn. It is called the "Union geared drill chuck." In its general construction it is the same as the "Czar drill chuck," made by the same builders for many years. The parts are of steel, and the standard of workmanship followed in the old chuck is carried out in this new one. The improvement in construction is the provision of a pinion meshing with a circular rack for rotating the knurled sleeve with a key, instead of by grasping it by hand, as was neces-

Geared Drill Chuck with Enclosed Pinion.

sary in the former construction. This has the well-known advantages of tighter gripping possibilities, and of making it unnecessary to hold the spindle with one hand while the tightening is done with the other. The particular construction followed in incorporating this improvement gives a pinion enclosed within the body of the chuck, which the builders believe is superior to the construction in which the gearing is outside, or in which the pinion is part of the wrench, as it insures perfect alignment of the pinion with the rack, and also avoids unnecessary wear of those parts.

BILLINGS & SPENCER MILLING MACHINE FOR DIE CUTTING.

The Billings & Spencer Co. of Hartford, Conn., is building the specialized form of milling machine shown herewith for making trimming and punching dies. It was developed originally for the making of these dies, in the shops of the builders, especially for drop forging work, but it is, of course, as useful for making the trimming and punching dies used in sheet metal work.

The salient feature of the machine is the inverted spindle, in combination with a work table provided with screw and hand-wheel movement in two directions. With this construction, by using a mill tapered to give the amount of draft desired for the die, the latter may be clamped in the chuck jaws shown on the table, and be worked out to fit the outlines scribed upon it, in such a way that the operator can follow the action of the cutter along the line with nothing to interfere with his vision. This is more convenient for this particular work than the ordinary vertical spindle milling machine, in which the cutting through has to be done blindly with the design on the lower side of the work, or has to be

done by the expedient of employing a mill having a reverse taper—that is, a larger diameter at the end than at the shank. Even when using such a mill, however, the cutter spindle obstructs the vision of the operator more or less.

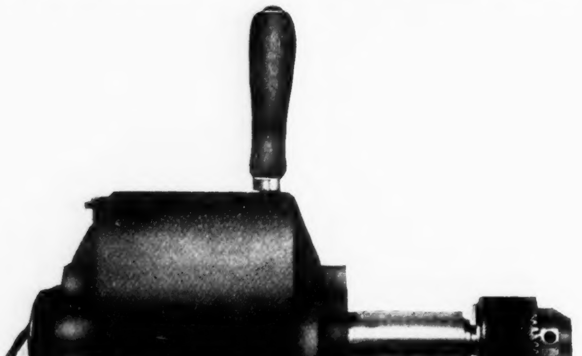
With this machine, the operator stands at the front, where he can control the movement of the work by the two cross-slide hand-wheels, one on his right and the other on his left. The inverted spindle holding the cutter is placed in the open-

An Inverted Milling Machine for Die Work.

ing of the heavy universal carriage. The construction of the spindle is such as to hold the cutter very rigidly, at the same time allowing it to be easily removed or replaced by the operation of the hand-wheel located at the base of the spindle, and partially seen in the engraving. In removing the cutter, the turning of the hand-wheel releases it and at the same time forces the collet outward, acting as a positive ejector. The spindle is provided with an efficient oiling system, insuring perfect lubrication to all the bearings. Four collets (3/8, 1/2, 5/8, and 3/4 inch diameter) are furnished with the machine.

WILLEY PORTABLE ELECTRIC BREAST DRILL.

The drill shown herewith is made by the Willey Machine Co. of Jeffersonville, Ind. The main feature of the design is the simplicity of its construction; this is a matter which has to be carefully considered in making a machine which will be durable under the rough usage to which tools of this



An Electrical Breast Drill of Simple Design.

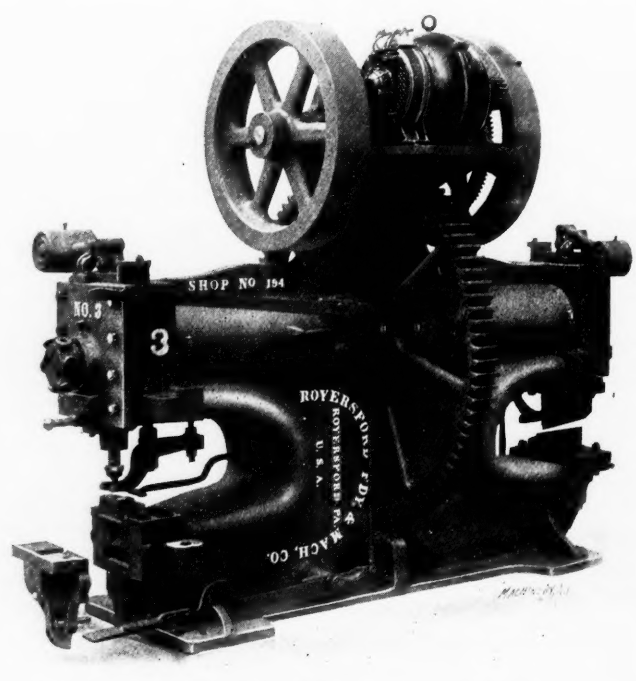
kind are often subjected in service. But two gears are used, both cut from solid bar steel. The drill spindle has two long bearings, with removable bushings of high grade phosphor bronze, in place of the single short bearing often met with in drills of this type. Owing to the low speed of the motor, the wear on the commutator, bushings, gears and bearings is comparatively slight. By simply removing two nuts the entire machine can be taken apart by any ordinary mechanic for inspection of the enclosed mechanism, no electrical knowledge being necessary. All these points tend toward increasing the durability of the tool, and facilitate inspection and maintenance.

All the electrical connections are attached to the main casing of the machine, and are not disturbed when it is taken apart for any purpose. A snap switch is located on the side of the frame, convenient for starting and stopping the drill. Special attention has been given to ventilation, insuring cool running and high efficiency of the motor. A system of air ducts has been provided in the armature for this purpose similar to those found in larger electrical apparatus.

The tool is made in four sizes, having a maximum capacity of 1/4, 3/8, 1/2, and 3/4 inch respectively in steel, the largest of these having two speeds. The motors are wound for either direct or alternating current and for any voltage up to 250. The side handle shown can be quickly attached or removed as required by the work in hand.

ROYERSFORD COMBINED PUNCHING AND SHEARING MACHINE.

Royersford Foundry and Machine Co., Royersford, Pa., has recently gone into a heavier line of punching and shearing machines than it has built for some years past. Having found a constant call for heavier work, the builders have designed the No. 3 punch and shear shown herewith, which is made with



Combined Punch and Shear for General Work.

either 26- or 32-inch throats on both sides, with the added provision of a 4-inch extension on the punch side, which gives a depth of 30 or 36 inches at this point.

These machines are suitable for general structural work, railroad shop, machine shop and boiler works purposes. They are of compact design and of simple construction, requiring very little floor space. Each side is independent of each other, but both sides can be operated together. The removable lower jaw on the punch side makes the machine very convenient for punching I-beams and channels.

The shearing capacity of the tool is for work up to 10 inches wide by 1 inch thick on flat stock, and 2 inches diameter for round stock. The capacity of the punch is for holes up to 1 1/2 inch in diameter in 1-inch plate. The machine with a 26-inch throat weighs 18,000 pounds, and with the 32-inch throat 21,500 pounds.

UNIVERSAL HACK-SAW FRAME.

The adjustable hack-saw frame built by the West Haven Mfg. Co. of West Haven, Conn., has recently been improved, resulting in the design shown in the accompanying illustra-

tion. This form the builders call their "1908 universal hack-saw frame."

This frame has been designed to meet the demands for increased length and lightness. It is made of a high quality of crucible steel 3/4 x 3/16 inch in section, highly nickled and polished. The small parts are case-hardened. The special feature of the design is the provision for adjusting the length of the frame for different sizes of blades. An improvement in this new model is the accurate graduations provided for setting the frame for these adjustments. The spaces are all marked for different lengths so that the proper

Adjustable Graduated Hack-saw Frame

position may be obtained at once. Another special feature is the fact that the blade is held in place by a knurled nut, so that it is impossible for it to fall off the pins when the strain is relieved for the purposes of adjustment. The blade is arranged to cut in four different positions without removing it from the frame.

The distance from the bottom of the frame to the cutting edge of the saw is 3⅛ inches. The handle is 1⅜ inch in diameter, and 4⅛ inches long. The list price is $1.00.

CUTLER-HAMMER MACHINE TOOL CONTROLLER.

We show herewith, in Figs. 1 and 2, a drum type machine tool controller which has recently been brought out by the Cutler-Hammer Mfg. Co., Milwaukee, Wis. The most noticeable feature of this controller is the fact that it is mounted in the same case with both the armature and field resistances, making unnecessary any special provisions for these pieces of

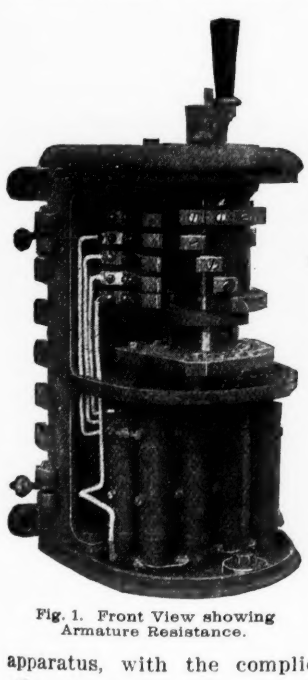


Fig. 1. Front View showing Armature Resistance.

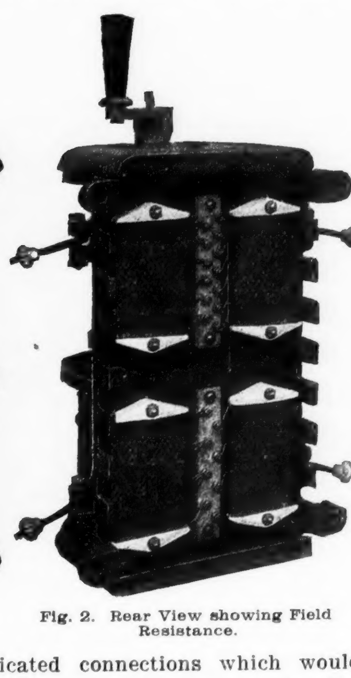


Fig. 2. Rear View showing Field Resistance.

apparatus, with the complicated connections which would otherwise be required, and which would have to be made after the apparatus is installed.

Fig. 1 is a front view of this new type of controller, and shows the removable resistance units mounted in the lower half of the frame with insulated wires running from each unit to metal contact fingers in the upper part of the device. These units constitute the armature resistance, and are employed for starting duty only. Fig. 2 is a rear view of the same controller, and shows another type of resistance unit, also removable, mounted in the back. The four units shown herewith constitute the field regulating resistance. They are each divided into five steps, giving twenty contact points in all, providing a range of variation in speed of from 2 to 1 to 3 to 1.

These controllers are made for both reversible and non-reversible motors, ranging from 1 to 7½ horse-power, and are designed for use on either 110 or 220 volt direct current circuits.

Garvin Machine Co., Spring and Varick Streets, New York. Milling machine with extra long feed, designed for work requiring long cuts; in other particulars similar to the No. 15 plain milling machine built by the same firm.

Henry Koch & Son, Nyack, N. Y. Test indicator suitable for general use in centering work in the chuck, lining parts in erecting machinery, testing workmanship, and other similar operations.

Williamson Vise Co., Bradford, Pa. Tilting drill press table for use in connection with any standard form of drill press. The square platen of this vise can be tilted at any angle from the vertical to the horizontal to permit the drilling of holes at any angle required.

H. A. Stocker Machinery Co., Chicago, Ill. The Rearwin emery wheel dresser having wheels with cutting blades arranged in spiral form so that they over-lap each other and make a continuous cut on the wheel. The teeth are said to be self-sharpening.

H. O. Costello, 87 Oakland Avenue, Providence, R. I. Quick adjusting micrometer in which, by means of a ratchet arrangement, the barrel is adjusted rapidly for position without requiring the thread to be screwed the whole length of the adjustment.

American Gas Furnace Co., 24 John Street, New York. Heating machine intended especially for tempering and coloring steel parts. It is made in the form of a tumbling barrel, uniformly heated, and provided with gas and air valves and a thermometer so that the temperature can be controlled accurately.

William P. Stein & Co., Rochester, N. Y. Surface grinding machine of the type in which the work to be ground is moved by hand over a flat table beneath the wheel; it is especially adapted to the sharpening of dies. The table is provided with grooves for catching loose emery.

New Departure Mfg. Co., Bristol, Conn. New Departure "Two-in-One" annular ball bearing. This bearing gets its name from the fact that it is designed to sustain both radial and thrust loads. In the compact type of double bearing, the balls are spaced by a sheet metal separator which preserves the relative position on all the balls in both races.

Baird Machine Co., Oakville, Conn. A tilted revolving barrel for drying small parts of wire or sheet metal in hot sawdust after being subjected to a wet tumbling or plating process. This barrel has double walls and is steam heated, the operation of emptying it being accomplished in the same way as with the builders' tilting tumbling barrel.

Higley Machine Co., 91 Liberty St., New York City. Revolving table type cold-saw, which may be set at any angle for cutting structural shapes, etc. It is provided with a friction feed which is so regulated as to automatically proportion the power of the cut to the resistance offered, thus saving the saw from being injured by a forced feed.

Rockford Tool Co., Rockford, Ill. Twentieth century balance tester for balancing pulleys, armatures and other rotating parts, in place of using parallel straight edges. The shaft is supported by four knife edge disks of large diameter, rotating on ball bearing pivots. The frames are adjustable to suit work of different lengths.

John B. Morris Foundry Co., 933 Harriet St., Cincinnati, Ohio. The Schellenbach lathe which we have previously il-

lustrated in the complete geared head type in our June, 1908, issue, but with the cone head and plain change gear mechanism substituted for the original geared changes. Otherwise, it has the same special features of taper attachment, improved carriage construction, etc.

MASSEY VISE CO., 176-178 S. Clinton St., Chicago, Ill. Parallel bar vise in which the parallel bars are fast to the removable jaw, and pass through widely spaced bearings in the stationary jaws, being connected by a yoke at the rear which slides on ways on a fixed guide attached to the movable jaw. This gives a support for the full length of the sliding jaw at all times.

KINSLER-BENNETT CO., Hartford, Conn. Two new types of universal joints; one of these is a form of the regular double fork and central block type, provided, however, with a shell which covers and protects the joint. In the other the construction has been modified, the fork of one member having a closed end, encircling the block, while the other member is in itself a shell which serves to cover the mechanism.

MORROW MFG CO., Elmira, N. Y. A ball bearing drill chuck. The jaws are forced down on the work by being pressed outward through a taper sleeve. The thrust of the tightening is taken by a ball joint, making it possible to get a very strong grip with comparatively little twisting action, as the work lost in friction is minimized by this construction.

E. W. BLISS CO., 5 Adams St., Brooklyn, N. Y. Large presses for making side seams in cylindrical work. This is a modification of the horn type of press; in this case, however, the horn is placed parallel with the crank-shaft of the double frame press, the work being inserted through an opening in the side of the press. It will press seams in work up to 30 inches in diameter and 40 inches in length.

F. E. REED CO., Worcester, Mass. A special lathe for manual training and pattern work, driven by a motor mounted in the cabinet base. The motor has a 3-step cone mounted in the armature shaft which is bolted directly to the spindle cone, the bed being of such form as to make this possible. These lathes are furnished with a complete outfit of accessories necessary for manual training and pattern work.

MESSRS. EDWARD BROWN & SON, 311 Walnut Street, Philadelphia, Pa. A portable pyrometer of the type in which a thermocouple is applied at the point where the temperature is to be measured, and the leads are connected with a sensitive volt meter to indicate the temperatures. For low temperatures a couple of heavy nickel allow or tungsten is used. This has a fusing point of 2,700 degrees Fahr. At higher temperatures a platinum-rhodium couple is used.

ARMSTRONG-BLUM MFG. CO., 113 N. Francisco Ave., Chicago, Ill. Marvel draw-cut hack-saw. Its characteristic features are the use of the draw-cut principle, and the provision of a spring tension appliance to bring pressure on the blade during its cutting stroke, which is relieved on the return. An automatic trip is provided for stopping the mechanism when the cut is finished. The machine has a strongly built frame and has a capacity for cutting stock up to 4 inches by 4 inches.

C. S. BONNEY, Irvington, N. J. Automatic reversible taper for use in tapping small holes up to 5/16 or 3/8 inch. The device is used in connection with a drill press or lathe, and is operated in the same way as a friction-driven reversing tapping machine. The main spindle runs constantly in one direction, the reverse being provided for in gearing within the attachment itself. The stopping and reversing of the tap are automatically effected at any desired depth by the setting of the stop provided.

WESTERN TOOL & MFG. CO., Springfield, Ohio. Champion combination tool holder. This holder is provided with blades and attachment which allow it to be used as a straight turning tool, side turning tool, boring tool, key-seating tool and in other combinations. The shank is a steel drop forging, case-hardened, as are the various other parts of the device. It is furnished complete for all the combinations of which it is capable, or with a selection of parts to make up any possible combinations desired.

OESTERLEIN MACHINE CO., Cincinnati, Ohio. Vertical milling attachment designed for use with the builder's No. 30 universal or No. 34 plain milling machines. It is designed to take as heavy a cut on the vertical spindle as can be taken on the main spindle, without chattering or other signs of distress. The attachment, which is adjustable to any angular position about the axis of the spindle of the machine, is strongly attached to the frame, being clamped both to the face of the column and to the overhanging arm.

OLNEY MACHINE WORKS, Philadelphia, Pa. An automatic cutter grinder for the grinding of either straight or spiral toothed end mills, cutters, etc. The machine incorporates provisions for automatically reciprocating the table and the work mounted on it, and for indexing the latter. The spiral attachment is very simple and easily adjusted, being made somewhat on the plan of the taper attachment for the lathe. The emery wheel may be set at any angle to suit the requirements of the tooth being ground.

JOHN STEPTOE SHAPER CO., Cincinnati, Ohio. A motor-driven shaper of very compact arrangement, in which the working parts do not extend out beyond the space occupied by the ordinary cone-driven shaper. The machine was originally designed for use on a United States revenue cutter. A variable speed General Electric motor is used which is connected with the crank-shaft by a gearing which gives two changes, the range of strokes per minute being thus obtained partly by mechanical and partly by electrical means.

POTTER & JOHNSTON, Pawtucket, R. I. Line of screw shaving and turning machines made in three sizes, the largest of which takes 3 inches in diameter through the spindle quill. The collet is operated by a pilot wheel, making it possible for the operator to perform all the movements necessary without leaving his position, even on a machine as large as this. The carriage carries a cross slide on which are mounted two tool slides. Both cross slides and tool slides are operated by levers, and all the movements provided with stops. The carriage is adjustable on the bed by means of a hand-wheel and screw to suit work of different lengths.

ROCKFORD DRILLING MACHINE CO., Rockford, Ill. Portable engine lathe mounted on trucks and especially designed for fitting and erecting, or for any operation where it is most convenient to take the lathe to the work. A counter-shaft and electric motor are mounted beneath the bed of the lathe. A two-speed change is provided in the head-stock, giving a slow speed for turning and a higher one for filing and polishing. This in combination with the five-step cone pulley in the counter-shaft gives ten speeds. A turret tool post is provided on the carriage so that any one of four tools is instantly available for use.

BULLARD MACHINE TOOL CO., Bridgeport, Conn. Boring and reaming bar for finishing cored holes and special grinder for keeping the cutters in condition. This boring bar has two openings at right angles to each other, one of square stock for the single pointed cutters, and the other for the floating double-ended boring blades. As shown used, the first cutter is a chamfering tool which cuts the scale away to permit the following tools to cut true and even without being thrown out and dulled by the rough scale. Roughing and truing blades follow in succession, and then a sizing cutter of the double-ended type which floats in a slot in the bar is used for bringing the hole almost to the size of the finishing cutter, which acts as a reamer. This finishing cutter is provided with a slot and a taper hole by means of which its size may be adjusted as it wears. The grinding machine provides for grinding cutting edges of the proper angles for all of these cutters.

ANNUAL CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The seventh annual convention of the National Machine Tool Builders' Association was held at the Hotel Imperial, New York, October 20 and 21. The association now has ninety-five members, four new concerns having been admitted since the June meeting. These are: C. H. Allen & Co., Barre, Mass.; Powell Planer Co., Worcester, Mass.; Barnes Drill Co., Rockford, Ill.; and W. E. Gang Co., Cincinnati, Ohio.

The matters of general interest to people outside the association, brought before the meeting were the papers: "A Review of the Department of Commerce and Labor's Report on the Conditions of the Machine Tool Industry in Continental Europe," by Captain G. L. Carden; "Different Plans of Paying Employes with the Advantages and Disadvantages of Each Plan to Employer and Employe," by Mr. Harrington Emerson; and "The Commercial Side of the Machine Tool Industry in Europe and a Review of European Conditions," by Mr. J. W. Carrel.

Captain Carden made a tour of European manufacturing plants during the past year, acting as special United States agent to investigate the conditions as regards foreign market for American machine tools. His paper was a general review of the situation and briefly summarized the articles published in the *Daily Consular Reports*, issued by the Department of Commerce and Labor, Bureau of Manufacturers, Washington, D. C. These reports will be prepared in monograph form later for general distribution. Captain Carden spoke of the strong competition rapidly developing in Germany, and emphasized that in his opinion Germany would be America's chief competitor in the manufacture of machinery and machine tools in the future. From being an importer of machine tools in large quantities, Germany has rapidly risen to the position where in 1907 it exported over 52,000 machine tools to twenty-three countries, reaching practically every country on the globe. He spoke enthusiastically of the great educational effect of the military training imparted in the German army service, and the resultant effect on industrial conditions. He earnestly advised the members of the association to take action with the view of providing for further stimulation of our foreign trade in machinery in every legitimate manner, and suggested that the policy of exporting men with the machines was one that should be followed more than it has been in the past. At the conclusion of this paper Mr. Doan, of the American Tool Works Co., Cincinnati, Ohio, made a motion to have a committee of twelve machine tool builders appointed to visit Washington and confer with department officials on the matter. This motion was carried.

Mr. Emerson's paper was the subject of warm discussion, there being the usual differences of opinion among specialists who have studied the production problem and reward for labor from the side of the manufacturers, devising ways and means by which workmen can be induced to produce more for a living wage. The sentiment was that the great difficulty confronting any scheme for fixing wages is the practical impossibility of determining what is a maximum day's production. The changes and improvements constantly developing in machine shop practice and machine tools makes a constantly changing state as regards labor and labor reward. For example, the introduction of high-speed steels in many cases reduced the time required for certain work to half or even a quarter the time required for the same operations using carbon steel.

Mr. Carrel's paper was also a review of European conditions as seen by him on a tour of investigation in machine tool shops. The consensus of these reports, and of those furnished by Mr. Oskar Kylin in MACHINERY, seems to be that which practically all fore-sighted manufacturers had already seen, that is, European builders would eventually reorganize and equip their shops along American lines. So well has our example been imitated in certain cases that American competition already is almost hopeless when our high tariff, high wages, and ocean freights are considered.

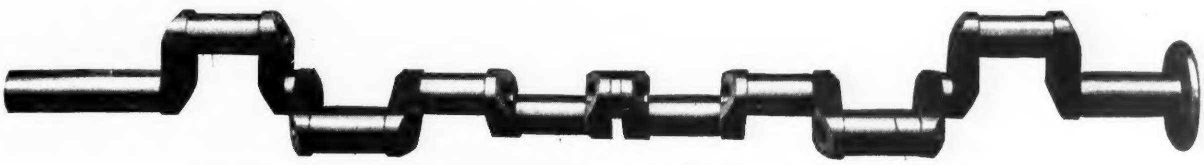
All the officers were re-elected, being as follows: President, Fred L. Eberhardt, Gould & Eberhardt, Newark, N. J.; first vice-president, C. A. Johnson, Gisholt Machine Co., Madison, Wis.; second vice-president, E. P. Bullard, Jr., Bullard Machine Tool Co., Bridgeport, Conn.; secretary, P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio; treasurer, W. P. Davis, W. P. Davis Machine Co., Rochester, N. Y.

* * *

A NOTABLE CRANK-SHAFT JOB.

The illustration shows a six-throw crank-shaft, forged and finished complete at the Chester Works of A. P. Witteman & Co., Philadelphia, Pa. It was made for the Chadwick Engineering Works, and was installed by this concern in the racing launch built for Mr. Herbert Austin, of Boston, Mass.

The forging was made from a 10-inch square chrome-nickel steel billet, the stock being thoroughly hammered and refined and then annealed for machining. The parts between the throws were then cut out and the forging twisted between each pair of crank webs, after which it was again annealed to relieve all the strains incident to the twisting operation. The shaft was then rough machined throughout and oil treated, following which it was finished and ground, all bearing surfaces being ground to limits of 0.0010 inch; that is, 0.005 inch above or below the given dimensions. The over-all dimension of the crank-shaft is 71¾ inches. The crank-pins are 2½ inches diameter, 4½ inches long, and the shaft bearings between the cranks are 2½ inches diameter and 4 inches long. The size of the crank webs is 6¼ × 2¾ × 1½ inch. The longitudinal holes through the crank-pins and bearings are 1⅛ inch diameter.



Six-throw Chrome-nickel Crank-shaft forged with Bearing between each Pair of Crank-webs.

The crank-shaft was made for a six-cylinder engine, the cylinders being 8 inches stroke by 7 inches diameter, and developing 150 horse-power at 850 revolutions per minute. The weight of the engine complete with all attachments is only 1,400 pounds. Anyone familiar with the manufacture of multiple throw crank-shafts can readily see from the illustration that the design is something quite different from the usual form of six-throw crank-shafts. It will be noticed that instead of combining the two crank-pin bearings in the one throw, each crank-pin bearing has a separate pair of crank webs. This, of course, increases the difficulty of manufacture. It will be noticed that the space between the cheeks in the case of the two end throws is very narrow, being only ⅝ inch. A twist had to be accomplished within this narrow space. It is evident from this fact that the material is of great toughness and strength.

The boat for which the crank-shaft was built is 37 feet long over-all with a beam of 4 feet 6 inches. The reversing gear propeller shaft was also built for the Chadwick Engineering Works by the Chester Works of A. P. Witteman & Co., and particular attention is called to the fact that the total weight of the reversing gear and shaft was only 222 pounds. A test piece taken from the shaft showed the following physical properties due to the heat treatment:

Tensile strength, 143,500 pounds per square inch;
Elastic limit, 110,000 pounds per square inch;
Elongation, 18 per cent in two inches.

* * *

A lot of people think that they are climbing the ladder of success when they catch hold of the other fellow's coat tails.—*The Silent Partner.*

MACHINERY'S SIXTH ANNUAL OUTING.

On October 22, following the convention of the National Machine Tool Builders' Association, MACHINERY gave its annual outing to five hundred machine tool builders, mechanical engineers, machinery dealers and others interested in the machine tool business and kindred lines.

The outing this year differed materially from preceding ones, the chief feature being athletic sports, and the contestants, members of the trade; in the games requiring team play the East was pitted against the West. The steamer *Sagamore* took the party to Point View Island, on the Sound, which had been hired for the day, and on which was a large pavilion and athletic field well suited for the sports. Music was furnished by the Eighth Regiment Band, and luncheon was served in the pavilion, which had been appropriately decorated for the occasion.

The sports which followed the luncheon comprised a potato race, a baseball game between the East and West, a sack race, a three-legged race, and a push-ball game, the contesting teams being chosen from Eastern and Western territory.

There were fourteen entries in the potato race, as follows: Charles H. Besly, F. C. Billings, F. B. Doe, W. S. Gorton, R. B. Jacobs, E. A. Johnson, T. G. Meachem, C. H. Peirson, L. D. Rockwell, E. C. Smith, A. K. Spencer, Charles A. Strelinger, W. W. Totman and E. H. Waring. Referee, Charles F. Chase. After an exciting and laughable contest Mr. Peirson was declared the winner of the prize, which was a sterling silver berry spoon.

The ball game, which was confined to one hour and won by the Western team, was remarkably good considering that none of the players had any previous practice together, the score being 8 to 7. The captains were C. A. Johnson of the Gisholt Machine Co., Madison, Wis., for the West, and D. B. Bullard of the Bullard Machine Tool Co., Bridgeport, Conn., for the East, and the players were as follows:

EAST.		WEST.
D. B. Bullard	Pitcher	W. L. Schellenbach
F. E. Bocorselski	Catcher	David Hunt, Jr.
P. B. Gale	1st base	R. T. Lane
W. H. Taylor	2nd base	R. K. LeBlond
P. M. Brotherhood	3rd base	A. M. Watcher
A. R. Stedfast	Shortstop	C. A. Johnson
H. C. Warren	Right field	Rufus King
D. M. Wright	Left field	H. W. Kreuzburg
U. Eberhardt	Center field	G. H. Feltes
Frank L. Cogill	Umpire	Winthrop Ingersoll

The prizes were emblems similar to those worn on watch fobs, but attached to ribbons in the form of a badge marked with the position played by each of the winning team.

There were twelve entries to the sack race, as follows: C. L. Goodrich, A. W. Graham, D. Halstead, C. E. Holgate, R. B. Jacobs, J. Judd, D. R. McIntosh, C. A. Mackintosh, S. Robertson, C. T. Schmitt, E. Von Campe and N. G. Williams. Mr. Goodrich was the winner of the prize, which was a decorated stein.

Fourteen entered the three-legged race, as follows: W. C. Buell and A. W. Graham; A. E. Carpenter and A. T. Doud; E. Von Campe and C. E. Chapple; C. E. Watrous and H. A. Pratt; C. T. Schmitt and C. L. Goodrich; W. H. Miller and R. B. Jacobs; J. Judd and J. B. Anderson. Messrs. Carpenter and Doud won the prizes—twin flower vases of green glass decorated with gold.

The game of push-ball is played by eleven men on each side, on a rectangular field 50 yards wide and 120 yards long, with goal posts at the ends, 20 feet apart. The ball used in the game is 6 feet in diameter, the object being to push the ball over the bar between the goal posts, and the rules are much the same as in foot ball. The push-ball game proved to be the most popular game of the day, and after a hard-fought battle, in which every inch of ground was contested and neither side was able to make a goal, the East won out by a few feet. The game was limited to two ten-minute periods, with a resting interval of five minutes between. Someone remarked that if all the people on the ground pushed as hard for business, there would soon be a boom in the machinery trade.

We were unfortunately unable to obtain a complete list of the Western team, as some changes were made just prior to the game, and after it everybody left for the steamer. An accurate list will be given with the views of the games which we are now having reproduced.

EASTERN ELEVEN.	WESTERN ELEVEN.
J. W. Bray,	C. H. Besly,
D. B. Bullard,	——— Booth,
E. Cramer,	W. A. Greaves,
Robert L. Crane,	Oliver Henn,
James Coulter.	D. Hunt, Jr.,
Oscar M. Flather,	Winthrop Ingersoll,
L. P. Goodspeed,	G. E. Merryweather,
R. B. Jacobs,	C. A. Strelinger.
C. H. Kingsbury,	
Marshall Prentiss,	
Geo. J. Thompson.	

Referee: Robert B. Luchars.

The push-ball prizes were similar to those for the baseball—one for each player—the ribbons being of a different color and the inscriptions appropriate.

The Push-ball Game—"Up in the Air."

The 1908 outing was generally considered to be the most successful of all those given by MACHINERY. In spite of the late date the weather was perfect, and all the events went off without a hitch. At the first outing, which was given six years ago, only twenty guests were present; while for 1908 nearly seven hundred acceptances and requests for invitations were received, although accommodations were provided for only five hundred, as a larger number would have caused overcrowding and discomfort to those who attended.

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A paper presented by Mr. Thomas D. West, Sharpsville, Pa., before the American Foundrymen's Association was an appeal for the prevention of accidents in the foundry. While brief, the paper contained some valuable suggestions, which, if followed, would go a long way toward preventing the distressing accidents that are of frequent occurrence in foundries. He mentions indolence, smoking, drink, forwardness, stupidity, rashness, deliberate carelessness, independence of orders, callousness regarding the safety of others, and perhaps deliberate trickery or spite as causes, mostly on the part of operatives. Next in order are mismanagement, disorder, tyranny, particularly in the overseers, and absence of safety devices and intelligent control of the works on the part of the management. A point that prevents men in charge from exercising all possible precautions for safety, is the lack of credit they get for taking precautions from those higher up. It is desirable that foremen and sub-foremen should be encouraged to see that nothing but a good bolt, or sound and annealed chain is used for handling flasks and ladles; that the temper of sand is watched, and the ramming, venting, coring, clamping and other operations incident to the foundry are carefully attended to; to notice that the ladles are dry, and that no one sticks wet rods into the metal or spills water over the gangways and around the cupola. These matters may appear small and trivial, but they are important factors in causing foundry accidents.

COOPERATIVE IDEA OF JOHN DALY, TRIMMER BOSS.

Only one remains of the five coal dump piers of the Delaware, Lackawanna and Western Railroad, which reared their high and grimy fronts over the North River on the Hoboken side in the days when John Daly, the trimmer boss, used to ride down from the heights to his work in his carriage every morning. Less coal is brought by the road now to this port, and machines like the floating grain elevators lift it from the cars on flat piers.

One alone of the six black skeleton structures survives—one was built since the time of John Daly—and only there can a few old timers be found who remember the story of this man, a story full of suggestion to students of remedies for the woes of the workingman.

Away back in the '70s John Daly used to leave his little apartment in an old fashioned Hoboken tenement house, dinner can in hand, at a quarter of 7 every morning except Sunday, and hurry to the coal docks. Then when the whistle blew he would crawl on his back, shovel in hand, from the hatch of a coal barge, well back under the deck, and begin to push and pile up the coal beyond his head until it touched the deck. So, laboring hard in a strained position, he and some ninety-nine others worked in an eighteen-inch or two-foot space most of the time, for that is the way the coal trimmers work.

For this work they got 22 cents an hour while actually engaged in shoveling. Their pay did not run when boats were not in, but often they worked late into the night, and at the end of the month they sometimes had $75 each to bring home. And they brought it home, for they were not tipplers or drunkards. So it went, winter and summer, for years.

John Daly was a shrewd man—an ambitious man. He saw clearly that it would be hard to fill the places of himself and his fellows if they should decide to go on a strike. He talked to the others about it when they were waiting for boats, until he had persuaded them all to join him in a cooperative bid for the contract, which would terminate with the outgoing of the then superintendent.

The new superintendent came and the trimmer boss made his offer for the contract, to last during the incumbency of this superintendent, at the old rate. John Daly stepped up and said:

"If you give this man the contract he will not be able to carry it out, for we will not work for him and he cannot fill our places. Give us the contract jointly and we'll stay and do the work. We don't need him at all to boss us; we know our business."

The new superintendent thought the matter over, and in a few days agreed to John Daly's proposal, for, indeed, there was nothing else for him to do. John Daly was elected boss trimmer.

Thereafter the pay of each man was sometimes as high as $140 a month, and the trimmers are now princes among laboring men. Then old Matt Casey died.

The men held a meeting to decide what to do about a man for his place. Would it be right to admit a new comer at once to the sharing which they had slaved for years to attain and had taken the risk of discharge to secure? Surely not, they agreed.

"Hire him at 22 cents an hour," they told John Daly, "and after a time, when we see fit, we'll put him on an equal footing with ourselves."

A man was hired at 22 cents an hour.

Many more of the cooperative trimmers died as the years rolled around, some retired because of old age, some had to retire because John Daly gave them heart breaking, impossible tasks, to drive them away, as they believed, and some John Daly discharged for one offense or another, until of all the hundred cooperative trimmers not one was left but John Daly, now sole contractor, and he had working for him a hundred men at 22 cents an hour.

John Daly was known on many an occasion to spend only $5 for the trimming of a boat for which he got $145. These were the days in which he used to come down from the heights to his work in his own carriage. He owned real estate in Jersey City and Hoboken. He was believed to be rich.

A new superintendent, a Mr. Varian, came about 1883, and a new contract had to be made with him. History repeated itself. The men demanded a contract as a cooperative body and the utter elimination of John Daly.

Mr. Varian would not deal with them as a cooperative body. They struck then for 25 cents an hour, and a settlement was made by which there should be no contract, but all the money which a contract would bring them would be divided among them fairly by Mr. Varian himself.

Again did the tenements rejoice in $145 as a month's pay instead of $90, and this condition lasted all through the superintendency of Mr. Varian. He was succeeded a few years ago by a Mr. Johnson, who, thinking that a couple of honest contractors would treat the men fairly, while relieving his office of a burden of care that did not rightly belong to it, gave the contract to Thomas Connelly, who used to be weighmaster in the old days, and a man named Miller, one of the old-timers who worked for Daly. They are the bosses there to-day, employing about ninety men, the new machinery making up the difference, and the pay of the men is 22, 25 or 30 cents an hour, according to the valuation the bosses put on their work. The pay averages about $45 every two weeks.

But what of John Daly? He went West, with plenty of money to enjoy himself, and he died about ten years ago, far from home and friends, and they say, on the lone, high black pier, without a penny to his name.

So did the selfishness inborn in humankind battle and win against the altruism necessary to the success of cooperation, and so did its triumph spell the ruin of the winner at last.—*New York Sun.*

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MISCELLANEOUS FOREIGN NOTES.

German Machine Exports.—The exports of machine tools from Germany have been on the increase during the first five months of 1908, in spite of the business depression. The exports during 1908 amounted to 19,486 metric tons, as compared with 13,798 metric tons for the first five months in 1907.

Extensions of the Krupp Works.—Some time ago it was announced that the Krupp firm, of Essen, Germany, was about to establish a branch in Roumania in order to supply the army with ordnance, and it was expected that the arsenal would be handed over to the firm for a period of years, and also that the firm would obtain a monopoly of governmental orders for iron and steel. The proposition, however, met with public disapproval, and has therefore been dropped for the present.

German Motor Car Industry.—It appears that at the present time greater attention than ever is given in Germany by the automobile manufacturers to small motor cars, many simply intended for a single passenger. In spite of the depression in the automobile business there is, even at the present time, a great demand for small and inexpensive cars, and many German firms are confident that they will be able to maintain the industrial stability of the motor trade by attending more to the production of vehicles for popular and business uses.

British Machine Tool Trade.—Reports from England indicate that the machine tool trade in the London district is comparatively good, considering the general depression in various other branches of engineering trades. As an indication of the fact that the depression in the machine tool trade in Great Britain is not so acute or general as in the United States, it may be mentioned that the firm of Henry Pels & Co. has enough work on hand to keep double shifts busy for several months, and is contemplating considerable extensions. This firm is building heavy tools in particular.

Iron and Steel Industries in Germany.—At a recent meeting of the National Association of German manufacturers of iron and steel, it was stated, according to report by Consul H. J. Dunlap, of Cologne, that the industry has been unusually prosperous during the past year, and that the output has been materially increased, caused, principally by the home demand. The financial panic in the United States, however, had an unfavorable effect on all industrial undertakings in the country, and caused a hesitancy in placing orders. However, the iron and steel industry in Germany is as yet fully employed.

One difficulty experienced has been that of shortage of railroad cars, an experience not altogether unknown also in the United States.

THE DEVELOPMENT OF RUSSIAN INDUSTRIES.—The South Russian iron and steel works are giving a great deal of attention to the production of the finer qualities of iron and steel. These works have not been in the habit of turning out higher grades of tool steel, but of late they have commenced with this manufacture, and some works turn out various qualities of high-grade steel at a moderate cost. It is stated that Russia may become independent of foreign industries for the supply of high-class metals, and that Russia in general, is forging ahead industriously. It is noteworthy of the progress of Russia along industrial lines that several Russian works have been competing with considerable success with other European engineering firms for contracts for the Roumanian state railways. Thus, a large consignment of rails, locomotives and freight cars have been supplied by Russian works for Roumania.

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PERSONAL.

L. B. Marks, New York, and J. E. Woodwell, Washington, D. C., have opened a consulting office in the Terminal Building, 41st Street and Park Avenue, New York.

J. G. Matthews, until lately with the Cleveland Twist Drill Co., Cleveland, Ohio, is now instructor in the mechanical drawing department of the Cleveland Technical High School.

H. P. James, formerly electrical engineer of the Bryant Electric Co., is now sales manager for the new line of push button specialties recently placed on the market by the Cutler-Hammer Mfg. Co., Milwaukee, Wis.

G. K. McMullen, for over ten years past sales manager of the Fox Machine Co., Grand Rapids, Mich., will sever his connection with that company November 15 to engage in business for himself. Announcement of the nature of the new venture will be made later.

Stanley H. Hodgkin of the Pulsometer Engineering Co., Ltd., Reading, England, is in the United States to make contracts with concerns desiring to manufacture patented machines in Great Britain in order to conform with the requirements of the new British patent law.

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OBITUARY.

Bennett H. Brough, a well-known British metallurgist and secretary of the Iron and Steel Institute, died at Newcastle-on-Tyne, England, October 3.

S. R. Stokvis, managing director and chairman of R. S. Stokvis & Sons, Rotterdam, died after a short illness, September 14. Mr. Stokvis was the son of the founder of the house, R. S. Stokvis, and was in his eighty-first year. A brief account of the activities of the company was published in the May, 1908, issue.

William Keuffel, president of the Keuffel & Esser Co., New York, died at his home in Hoboken, N. J., October 1. Mr. Keuffel was born at Walbeck, Germany, 1838, and was educated in the public and private schools of his birth-place. At the age of fifteen he left school and became an apprentice in a general merchandise store where he remained four years, receiving a severe but thorough mercantile and business training which fitted him for his successful career of later years. He then entered a large hardware house in Hanover, Germany, and several years later went to Birmingham, England. In 1866 he emigrated to the United States, where in 1867 he founded, together with his friend Hermann Esser, the firm of Keuffel & Esser. Drafting at that time was in its infancy in this country, but Mr. Keuffel appreciated its coming importance, accompanying the development of American manufacturing and engineering enterprise. To supply all the requirements in office and field of the surveyor, engineer, architect and draftsman was the purpose of the new concern,

William Keuffel.

and Mr. Keuffel can well be called the pioneer in this line, because at the time of the founding of his business, drafting supplies had not been carried exclusively by any house in the United States. The company now has a large factory in Hoboken, covering about five and one-half acres of floor space, and employing about 1,000 people. The new plant was opened July 20, 1907, forty years after the inception of the business. (See MACHINERY, August, 1907.) Mr. Keuffel is survived by a widow and four children, of whom Mr. W. G. Keuffel is the vice-president of the company.

* * *

COMING EVENTS.

November 10.—The November meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 West 39th St. Mr. Franklin Phillips, president of the Hewes & Phillips Iron Works, Newark, N. J., will make an address: "The High Powered Rifle and Its Ammunition—Instruments of Precision," illustrated by lantern slides. Mr. Phillips is an expert marksman, and in 1903 won the position as first alternate on the International Rifle Team to England. He was, for many years, chairman of the committee on Rifle and Pistol Practice in the National Guard of New Jersey and is now Ordnance Officer of the Second Infantry of that state. Tests of rifles and ammunition at Sea Girt, N. J., by men connected with the N. J. National Guard have led to marked improvement in arms and ammunition and to an entire change in the powder used by the government, thereby greatly increasing the accuracy of the shot. The improvement has been extended to large guns and instead of 2 per cent hits which were made at Santiago, 80 per cent is now the average in some ships. Mr. Phillips has actively participated in this work and as he is primarily a mechanical engineer, as well as a marksman, he will explain to his audience the practical bearing of his investigations upon the construction of arms and the elements entering into ammunition.

November 19-21.—Annual meeting of the National Society for the Promotion of Industrial Education, Atlanta, Ga. James P. Haney, 546 Fifth Ave., New York, secretary.

December 1-4.—Annual convention of the American Society of Mechanical Engineers, Engineering Societies Building, 29 West 39th St., New York City. C. W. Rice, 29 W. 39th St., New York, secretary.

December 10.—Mr. M. A. Loeb, secretary and treasurer of the Rock Island Battery Co., Rock Island, Ill., has issued a call to the manufacturers and dealers of gas and gasoline engines, and dealers and manufacturers of accessories thereto, to attend a preliminary meeting at the Auditorium Hotel, Chicago, December 9, 1908, with a view of discussing and formulating plans for the formation of an association. Officers are to be elected and a committee appointed for the purpose of arranging for a national convention to be held at some time and place decided upon by the executive committee.

December 31-January 7.—Ninth annual show of the American Motor Car Manufacturers' Association at Grand Central Palace, New York City.

January 16-23.—Ninth annual show of the Association of Licensed Automobile Manufacturers at Madison Square Garden, New York.

NEW BOOKS AND PAMPHLETS.

ANNUAL REPORT OF THE STATE GEOLOGIST OF THE GEOLOGICAL SURVEY OF NEW JERSEY. 192 pages, 5½ x 9 inches. Published by the state geologist, Henry B. Kümmel, Trenton, N. J.

MODIFICATION OF ILLINOIS COAL BY LOW TEMPERATURE DISTILLATION. By S. W. Carr and C. K. Francis. 48 pages, 6 x 9 inches. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

REPORTS OF COMMITTEES, 16TH ANNUAL CONVENTION OF THE TRAVELING ENGINEERS' ASSOCIATION, Detroit, Mich., August 25, 1908. 84 pages, 6 x 9 inches. Secretary, W. O. Thompson, New York Central and H. R. R., East Buffalo, N. Y.

HOW TO BUILD UP FURNACE EFFICIENCY. By Jos. W. Hayes. 47 pages, 3½ x 6¼ inches. Published by Jos W. Hayes, 601 Hartford Bldg., Chicago. Price 50 cents.

The pamphlet is a dissertation on furnace efficiency, and the facts that are to be learned by analyses of flue gases. It is of interest to all concerned with economical power production and smoke prevention.

LIGHTING COUNTRY HOMES BY PRIVATE ELECTRIC PLANTS. By T. H. Amrine. 35 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This is Bulletin No. 25, issued by the University of Illinois. There are special sections of the bulletin devoted to selection of fixtures and planning of lighting, the design of plant, estimated cost of plant, operation and care of apparatus, and cost of operation.

A DICTIONARY OF ELECTRIC RAILWAY MATERIAL. Compiled by the Electric Railway Journal. 184 pages, 6 x 9 inches. Published by the McGraw Publishing Co., New York City.

This dictionary gives a brief description of a very large percentage of the principal types of electric railway apparatus manufactured in the United States, and also information regarding leading dealers, engineers, and contractors doing business with street and interurban railway companies.

THE MODIFICATION OF ILLINOIS COAL BY LOW TEMPERATURE DISTILLATION. By S. W. Parr and C. K. Francis. 48 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This pamphlet is Bulletin number 24, issued by the University of Illinois. It describes experiments undertaken in order to determine the conditions under which it is possible to remove from bituminous coals the heavy hydro-carbons contained, and to produce a fuel essentially smokeless.

A PRIMER OF WOOD PRESERVATION. By W. F. Sherfesee. 15 pages, 6 x 9 inches. Published by The United States Department of Agriculture, Washington, D. C.

This pamphlet, which is known as Circular 139 of the Forest Service, contains several valuable hints regarding preservation of wood, and reviews different processes in use in the United States for retarding decay of wood. The pamphlet also contains a list of the material previously issued by the Forest Service of the Department of Agriculture, dealing with wood preservation. From time to time, the Department has issued not less than twenty bulletins on this subject.

INTERCORPORATE RELATIONSHIPS OF RAILWAYS IN THE UNITED STATES AS OF JUNE 30, 1906. Prepared by the Division of Statistics and Accounts of the Interstate Commerce Commission. 516 pages, 6 x 9 inches. Published by The Interstate Commerce Commission, Washington, D. C.

This compilation of statistics shows the amount of stock in various railroad corporations held by other railroads. In some cases where the intercorporate relation between the various railroads is so intricate as to be difficult to explain in words, charts have been prepared, showing in diagrammatical manner the ownership of the stock of the various railroads.

TIN PLATE WORKING. By R. H. Clarke. 44 pages, 5 x 7¼ inches, and twelve folded plates of line engravings. Published by the Technical Publishing Co., Ltd., 55-56 Chancery Lane, London, England. Price 1 shilling 6 pence net.

This book is particularly intended for manual training schools, and has been written specifically for the students preparing for the manual training teachers' examination at the City and Guilds of London Institute. The book gives specific instructions for making a great number of different commercial articles of tin plate, and includes illustrations showing how to lay out the plate, as well as several half-tone engravings from photographs showing different methods of doing more difficult parts of the work. The statements are very concise, and are likely to appeal to instructors in manual training schools.

MODERN POWER GAS PRODUCER PRACTICE AND APPLICATIONS. By Horace Allen. 326 pages, 5 x 7¼ inches. Published by the Technical Publishing Co., Ltd., 55-56 Chancery Lane, London, England. Price 6 shillings net.

The author's aim in presenting this book has been to define the ruling principles of the gasification of fuel, and describe commercial types of producers. The material from which the book has been prepared appeared originally in separate articles in the columns of the *Practical Engineer*, but recent developments of gas producer practice have necessitated extensive revision of these articles. By describing the most recent inventions and the claims made by the inventors, the author has placed comprehensibly before the reader the problems which are at the present time occupying the minds of engineers engaged in the design of gas producers. A great number of diagrams and line engravings serve to illustrate the various methods and designs described.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES. 1320 pages, 7¼ x 10 inches. Seventeenth edition. Published by Samuel E. Hendricks Co., 74 Lafayette St., New York. Price, $10.00.

This publication, which is an annual index of architectural, mechanical, engineering, contracting, electrical, railroad, iron, steel, hardware, mining, exporting and kindred industries, contains over 350,000 names and addresses and over 31,000 business classifications. It not only includes full lists of manufacturers, but lists of dealers as well. The work was first issued in 1891, and has grown from about 500 pages to over 1,300 pages. The index of contents has grown from only eight pages to 82 pages, four columns to a page, 106 lines to a column. The work is so classified that it may be used either for purchasing or mailing purposes. It undoubtedly is the most comprehensive directory of the class published, and is indispensable to dealers, buyers, purchasing agents and others requiring a complete classification of the trades and products.

FOUNDRY WORK. By Wm. C. Stimpson. 150 pages, 6½ x 9½ inches. Published by the American School of Correspondence, Chicago, Ill. Price $1.00.

Written especially for self-instruction, this book is a practical guide to modern methods of molding and casting iron, bronze, steel and other metals, and includes many valuable hints on shop equipment and management. It has been the author's aim to present the book so simply that the matter contained would be comprehensible to the apprentice, but at the same time, the treatise is so thorough that the skilled molder will find many valuable hints in the book that will increase his knowledge of his trade. The language used is simple and clear, and heavy technical terms have been avoided. The arrangement of the matter is such as to carry the reader along by easy stages, and frequent examples from practice are given. The book is divided into three distinct parts, the first of which treats of Materials and Methods of Molding; the second of Making and Finishing Castings; and the third of Shop Management. This last division also contains a number of tables useful to molders.

BOILER ACCESSORIES. By Walter S. Leland. 123 pages, 6½ x 9½ inches. Published by the American School of Correspondence, Chicago, Ill. Price $1.00.

Of late years the need for books which treat a limited subject in the mechanical field specifically, has become more and more apparent, and the American School of Correspondence has brought out a number of books which deal each with one limited division of mechanical knowledge; by doing so, it is possible to present a more complete treatise on this particular subject than is possible in a large work trying to cover the whole territory of mechanical engineering. This book deals specifically with boiler accessories, boiler setting, control and supply devices, and one part of the book is devoted to the troubles met with in boiler operation, and the carrying out of tests. In preparing this material it has been the aim of the author to lay special stress on the practical side of the subject, treated as distinct from mere theoretical and academic discussion. The book is illustrated with seventy-two line engravings and several half-tones made from photographs of existing boiler plants.

NOTES ON PRACTICAL MECHANICAL DRAWING. By Victor T. Wilson and Carlos L. McMaster. 160 pages, 6 x 9 inches. Published by the authors at East Lansing, Mich.

As indicated by the title, this book is a collection of notes on practical mechanical drawing, which were originally the subject matter of a course of lectures, and which have been prepared and placed in book form in order to meet the needs of students in engineering courses. The book differs to a considerable extent from the common standard text-books on mechanical drawing, in regard to both arrangement and contents, and it contains some material not heretofore discussed, or but little dwelt upon, in existing books on the subject. It will make a strong appeal to practical men inasmuch as it differs in its methods from those still in vogue in many colleges where the elementary training consists merely of a collection of exercises in purely geometrical drawing. This book presents a method where these exercises are reduced to a minimum, and where practical problems take their place. The authors state in the preface that the book is not considered complete, but that it is in process of making, and the experienced gained from its use in the class-room will furnish information required for its completion. However, the chapters contained in the book give a very complete treatment on the subjects they are intended to deal with, and the book should be valuable alike to the teacher and the student of mechanical drawing.

STEAM POWER PLANT ENGINEERING. By G. F. Gebhardt. 816 pages, 6 x 9 inches, 461 illustrations. Published by John Wiley & Sons, New York City. Price $6.00.

The field covered by the title of this book is a large one, and the author says in the preface that it has been necessary to limit the matter contained to the treatment of essential elements, but in spite of this, the book presents an unusually complete and concise treatise on the present state of steam engineering. The book is the outcome of a series of lectures by the author in the capacity of professor at the Armour Institute of Technology, to the senior class of the institution. While the book is primarily intended as a text-book for engineering students, it will be certain to interest practical engineers. The matter included is representative of present American practice, and no effort has been made to include foreign methods or designs except in a few special cases. One of the valuable features of the book, besides the many well made engravings, is the great number of tables relating to many different phases of steam engineering, there being more than 100 tables of data included. The most important chapters are headed as follows: Fuels and Combustions; Boilers; Smoke Prevention, Furnaces, Stokers; Superheated Steam, Superheaters; Mechanical Draft; Steam Engines; Steam Turbines; Condensers; Feed Water Purifiers and Heaters; Pumps; Piping and Pipe Fitting; Lubricants and Lubrication; Finance and Economics; Cost of Power; Testing and Measuring Instruments.

AMERICAN MACHINISTS' HANDBOOK AND DICTIONARY OF SHOP TERMS. By Fred H. Colvin and Frank A. Stanley. 511 pages, 4 x 7 inches. Published by the Hill Publishing Co., New York. Price $3.00.

This handbook contains a great deal of useful information which undoubtedly will be appreciated by the mechanical trades, presenting, as it does, in convenient form, such data as will be of value to practical men. It contains a great number of tables pertaining directly to shop and drafting-room work, as well as a number of such mathematical tables as will be found useful in a handbook of this kind. A dictionary of shop terms is included, which will be of service to younger mechanics, and which may help to establish standard names for various parts, where the nomenclature is now more or less confused. Much of the information contained has previously been published in the same or slightly modified form in the *American Machinist* and MACHINERY, and many of the tables contained have never before appeared in print, or been available for reference, in substantially the same form, except in MACHINERY'S Data Sheets. This fact, together with a review of the contents, will perhaps give the best idea of the value of the book. The main subdivisions of the book are headed as follows: Screw Threads; Cutting Screw Threads; Standard Proportions of Screw Threads; Measuring Screw Threads; Pipe and Pipe Threads; Twist Drills and Taps; Files; Work Benches; Soldering; Gearing; Milling Cutters; Milling Machine Feeds and Speeds; Cam Milling; Tables for Use with the Dividing Head; Milling Cutter, Reamer and Tap Flutes; Grinding and Lapping; Grinding Wheels; Reamer and Cutter Grinding; Screw Machine Tools; Punch Press Tools; Bolts, Nuts and Screws; Calipering and Fitting; Dimensions of Keys and Key-Seats; Tapers and Dove-Tails; Tables of Standard Tapers; Standard Jig Parts; Tables of Dimensions of Standard Machine Parts; Wire Gages; Belts and Shafting; General Reference Tables; Shop Trigonometry; Dictionary of Shop Terms.

LATHE DESIGN FOR HIGH AND LOW SPEED STEELS. By John T. Nicolson and Dempster Smith. 402 pages, 6½ x 10 inches. 255 illustrations and numerous tables. Published by Longmans, Green & Co., New York City. Price $6.00.

The present work is probably the most complete treatise which has ever been published on the kinematical and dynamical principles governing the construction of metal turning lathes. This is in evidence throughout the work, and is also vouched for by the co-authorship of Professor Nicolson, whose far-reaching experiments on metal cutting, carried out along the same lines as those by Mr. Fred W. Taylor in this country, are well known to mechanical men. The substance of the book has already appeared, in large part, in the columns of the *Engineer*, but a great deal of additional matter has been added in order to present a complete treatise on the subject. The book is based on the results of experiments upon the durability of tool steels, carried out at the Manchester Municipal School of Technology, researches upon the cutting forces acting upon lathe tools, carried out at the same institution, and on data and particulars collected from the practice of many well-known machine tool builders. From these various data, the authors have presented a treatise leading up to a rational design of lathes. The book deals in the first part with the experiments already mentioned carried out by the Manchester School of Technology. Some of the chapters in this section are headed: Friction of Shaving; Formation of Shaving at Low Speed; Formation of Shaving at High Speed; Best Tool Angle for Durability; Variations of Speed of Cutting with Duration of Cut; Standard Area of Cut; Standard Cutting Speed for High Speed Steel; Power of High Speed Lathes. The principles and conclusions arrived at are then applied to the design of lathes, and different chapters deal with belt tension, the design of spindle cone and spindle, all-geared headstocks, bearings, lubrication, countershaft, and feed mechanism. The design of all the different parts of the lathe are treated very thoroughly, and theoretical and practical investigations are made the foundation of all conclusions. An interesting chapter is devoted to the economics of machining in the lathe and the factors which govern the total cost. Diagrams showing at a glance the relationship between the various factors entering into lathe design are given throughout the work. In the comprehensiveness of its scope and the thoroughness of its treatment, it is safe to say that no other book has as yet been published on this subject, which can be compared with this work.

CATALOGUES AND CIRCULARS.

DEAN BROS., Indianapolis, Ind. Catalogue 71 of power pumps.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin 4611 on sewing machine motors.

FOOS GAS ENGINE CO., Springfield, Ohio. Catalogue of Foos gas-engine-driven hoist for mining, contracting, and general purposes.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin 4617. Illustrating and describing direct-connected generating sets.

KEMPSMITH MFG. CO., Milwaukee, Wis. Mailing card illustrating Kempsmith milling machines.

If you haven't received a copy of SELF-EDUCATION, just issued by MACHINERY, we will send you one by return mail, free of charge, upon receipt of your name and address and the name of your works. This very interesting periodical contains a set of

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HOLROYD & CO., Waterford, N. Y. Set of handsome picture postcards used by the company for acknowledging orders.

GENERAL ELECTRIC CO., Schenectady, N. Y. Circular illustrating and describing the multi-catch socket for incandescent lamps.

ABENAQUE MACHINE WORKS, Westminster Station, Vt. Circular illustrating and describing the Abenaque gasoline traction engines.

WHITING FOUNDRY & EQUIPMENT CO., Harvey, Ill. Catalogue illustrating foundry tumblers of different descriptions—gear-driven, roller-driven or friction-geared.

EUGENE DIETZGEN CO., New York. Circular showing the Economy beam compass, in which any ordinary pencil or drawing pen can be used.

WESTON ELECTRICAL INSTRUMENT CO., Waverly Park, Newark, N. J. Catalogue of new Weston instruments for alternating and direct currents.

INGERSOLL-RAND CO., New York. Booklet 21A entitled Electric-Air Rock Drills and Channelers; No. 36A, Compressors; No. 47A, Rock Excavating Machinery; No. 74B, Pneumatic Pumping Systems.

BILLINGS & SPENCER CO., Hartford, Conn. Leaflet of rod and yoke ends for automobiles, made according to the Association of Licensed Automobile Manufacturers' standard.

GISHOLT MACHINE CO., Madison, Wis. Leaflet illustrating Gisholt boring and turning mills, made in four sizes, *viz:* 52, 60, 64 and 72 inches swing.

AMERICAN BRAKE SHOE & FOUNDRY CO., 405 Western Union Building, Chicago, Ill. Circular calling attention to the company's products of manganese steel castings for mining and smelting works.

UNION MFG. CO. New Britain, Conn. Folder illustrating and giving prices of round and square base Union planer chucks, especially designed for planer and shaper work.

CHICAGO PNEUMATIC TOOL CO., Fisher Building, Chicago, Ill. Advanced sheets of catalogue No. 26, devoted to the Franklin air compressors, built at the Franklin, Pa., works.

WALTER D. CARPENTER CO., 39 Cortlandt St., New York. Leaflet advertising "Graphlio" grease, which is a specially prepared mixture of neatsfoot oil and "Graphlio." For description of "Graphlio," see MACHINERY, September, 1908.

MASON REGULATOR CO., Boston, Mass. Circular of the Mason pressure regulators, standard and special reducing valves, steam pump pressure regulators, and pressure controlling devices for operating clutches and for similar service.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind. Bulletin No. 1111, entitled Electric Motor Drives Applied to Machine Tools. This excellently printed and well illustrated publication shows a great number of interesting applications of motors to modern machine tools

HARRIS SMOKELESS FURNACE CO., Nashville, Tenn. Catalogue of the Harris smokeless furnaces, illustrated with a number of halftones, showing the application of the Harris smokeless furnace to boilers.

SPRAGUE ELECTRIC CO., New York. Circular No. 432, illustrating a new line of fittings for use with the company's make of flexible steel conduit; and circular No. 433, describing a new single-strip type of flexible steel conduit, designed especially for fireproof buildings.

WESTERN ELECTRIC CO., Chicago, Ill. Bulletin No. 5910-8, entitled Electrical Equipment for Mines, showing ore separators, zinc refining plants, power plants, together with motor and exhaust fans in use in various mines and refining works in the country.

WALTHAM MACHINE WORKS, Newton St., Waltham, Mass. Catalogue of bench lathes and attachments, automatic gear and pinion cutters. The catalogue illustrates recent improvements made in the lathe of much interest to toolmakers and others requiring the service of a bench lathe.

CINCINNATI PLANER CO., Cincinnati, Ohio. Catalogue of variable speed planers, illustrating the company's plant, product, and details of construction. The company has made a special study of variable speed planers, and data are included on high-speed performances, with power of motors required.

HILL CLUTCH CO., Cleveland, O. Catalogue of collar oiling bearings in various mountings. The company has in preparation a new edition of its general catalogue covering a complete line of power transmission machinery. The supplementary catalogue is a reprint of a special portion of this larger catalogue.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Circular describing the Peerless high-speed reamers, of both the solid and the expansion type. These reamers are made in the following different styles: hand reamers, core reamers, chucking reamers, shell core reamers, and shell chucking reamers.

cular of pressure pumps having capacity up to 250 pounds per square inch pressure. These pumps are especially designed for testing valves and other brass fittings, but, of course, can be adapted to any requirement of a similar nature.

HOSKINS CO., 93 Erie St., Chicago, Ill. Circulars of the Hoskins heat-gage or electric pyrometer, the Hoskins electric combustion furnace for rapid determination of carbon contents of steel, the Hoskins electric muffle furnaces, electric laboratory hot plate, and electric melting furnaces for commercial work.

GENERAL ELECTRIC CO., Schenectady, N. Y. Circular No. 3702, describing new type CR feeder-regulator, designed for operation on single-phase, 220-volt, 60-cycle circuits. Circular No. 3705, describing 25-watt tantalum lamp. Bulletin No. 4621, describing luminous arc lamps for multiple circuits.

J. NORMAN JENSEN, 797 N. Leavitt St., Chicago, Ill. Circular illustrating the use of Jensen logarithmic cross-section paper on which "all curves are straight lines." The use of this cross-section paper saves much labor in plotting curves in which the variable of the equation is a power or a root.

ELGIN TOOL WORKS, Elgin, Ill. Catalogue No. 3 of precision bench lathes and attachments. The catalogue shows and describes the Nos. 3 and 4 precision bench lathes, with counter-shaft and attachments. The attachments consist of compound slide rest, milling attachment, grinder, saw table, chucks, centers, etc.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4619, entitled Steady vs. Unsteady Voltage for Incandescent Lighting on Alternating Current Systems; No. 4622, Polyphase Maximum Watt Demand Indicator; No. 4616, High Voltage Type H Transformers; No. 4618, Belt-Driven Alternators.

W. S. ROCKWELL CO., 50 Church St., New York. Circular describing the Rockwell crucible melting furnace for copper, brass, bronze, aluminum, silver, gold, nickel, iron, or steel, using oil or gas fuel. The circular shows both half-tone illustrations and sectional line engravings of the design of the furnace and contains a detailed description of same.

WESTMACOTT GAS FURNACE CO., Providence, R. I. Catalogue 1908, describing gas furnaces, particularly those intended for high speed steel, bench forges, shop forges, and furnaces for hardening and annealing in general. Dry or air tempering furnaces, oil tempering furnaces, soft metal melting furnaces, and plating furnaces are also included.

CONSOLIDATED SUPPLY CO., 321 Dearborn St., Chicago, Ill. Loose leaf catalogue, showing portable pipe bending machines, pneumatic turn-table mules, railway car couplers, metal car roofs, and miscellaneous tools and railway supplies. Special attention is called to the Consolidated patented metal car roof illustrated, which has just been placed on the market.

INGERSOLL-RAND CO., New York. Catalogue of small power-driven air compressors, showing the different types of compressors made by the company, as well as their application. Various uses for compressed air are referred to and illustrated. A number of pneumatic tools, such as riveting and chipping hammers, scaling hammers, and rotary drills, are also described and illustrated.

CHICAGO FLEXIBLE SHAFT CO., 149 La Salle Ave., Chicago, Ill. Booklet entitled The Art of Good Case-Hardening, giving directions for the proper use and care of case-hardening plants, and illustrating the Stewart case-hardening furnaces and the Hoskins pyrometer. The booklet contains some interesting information regarding case-hardening, and is sent to superintendents and those interested in case-hardening on request.

FAY MACHINE TOOL CO., Second and Glenwood Ave., Philadelphia, Pa. Catalogue of the Fay automatic lathe for machining castings, forgings, etc. Samples of work are illustrated, giving the rate of production and cost. The catalogue also illustrates the Fay automatic cam cutter which was specially designed for automatically cutting designs such as are used on webbing and suspender looms. Another machine illustrated is the Fay automatic drilling machine for drilling, threading and tapping.

CARLYLE JOHNSON MACHINE CO., Hartford, Conn. Catalogue D, 1909, of the Johnson friction clutch, illustrating the various types of friction clutches manufactured, together with various applications. This catalogue is larger than previous editions issued, and contains considerable additional information in regard to driving machinery successfully through friction clutches. Special attention is given to the driving of machinery direct from the line-shaft, thus eliminating counter-shafting.

ASSOCIATION OF LICENSED AUTOMOBILE MANUFACTURERS, 7 East 42nd St., New York. Circular showing the standard spark plug adopted by the association, together with specifications. It is also announced that the 1909 handbook of gasoline automobiles will be issued in a few weeks. This is the sixth annual handbook of gasoline automobiles published by the association. While it contains a great deal more matter than previous editions, there is but little change as regards the size of the book or arrangement of the material.

HALCOMB STEEL CO., 79-81 S. Jefferson St., Chicago, Ill. Booklet of Halcomb tool steel made by the Halcomb Steel Co., Syracuse, New York. The company manufactures crucibles and high-speed tool steel for every purpose. The booklet is unique in several respects. It reproduces in colors the labels that are pasted to the various brands of steels manufactured. These brands include "Saben," high-speed, and "Ketos" air-hardening steels. Tables of heats and temper colors, and heat temperatures and colors for hardening are given, which have been deduced by pyrometer tests, and independently confirmed by other hardeners using different instruments. The booklet will be found of much value to smiths and others working tool steel.

MANUFACTURERS NOTES.

WINDSOR MACHINE CO., Windsor, Vermont, is building an addition to its erecting department, 50 x 100 feet, the increase of space being necessary because of the demand for the Gridley multiple-spindle automatic lathe.

THE office of the secretary of the New York Railroad Club, Central Railway Club, and International Boilermakers' Association has been removed from 62 to 95 Liberty St., New York. Mr. Harry D. Vought is the secretary of all three associations.

NATIONAL-ACME MFG. CO., Cleveland, Ohio, has taken advantage of the dull season to develop the single drive on its Acme automatic multiple spindle screw machine. One belt or one motor takes the place of multiple belts. A description of this improvement appeared in the June, 1908, issue of MACHINERY.

SPRAGUE ELECTRIC CO., New York, has opened another office in Southern territory in addition to the New Orleans office, the new office being in Atlanta, Georgia. Both offices are under the management of Mr. F. V. L. Smith, who has been in charge of the New Orleans office since its establishment. The Atlanta office is located in the Empire Building.

CLEVELAND CRANE & CAR CO., Wickliffe, Ohio, has changed its firm name to the Cleveland Crane & Engineering Co., under which title its production will be confined to the exclusive manufacture of cranes of every description, including traveling, gantry, mono-rail, and grab-bucket, and handling equipment of various forms. The new name will thus accurately describe the product.

CLEVELAND AUTOMATIC MACHINE CO., Cleveland, Ohio, has opened a display room at 67 W. Washington St., Chicago, Ill. The showroom will be equipped with four Cleveland automatic screw machines tooled for various shapes. One 2-inch machine is equipped for turning pistons, the work being done in eight minutes, ready for the grinding machine.

HILDRETH MFG. CO., Lansing, Mich., has been reorganized, and all the stock held by the Hildreth family has been sold to R. H. Scott and E. F. Peer, who are at present the president and vice-president of the company. N. E. Hildreth, at present treasurer of the company, and superintendent of the gasoline engine department, will sever his connection with the company as soon as his successor is appointed.

FAIRBANKS-MORSE & CO., Chicago, Ill., has recently installed a 9 H. P. gasoline engine at the new bascule span across the Cuyahoga river, Cleveland, Ohio, for operating the bridge, if there should be any trouble from defective current in the regular electrical equipment, which consists of two direct current electric motors of 50 H. P. each. The 9 H. P. engine will lift the bridge in 12 minutes in an emergency.

MANVILLE BROTHERS CO., 27-33 Benedict St., Waterbury, Conn., has purchased from Frederick E. Cross of the Cross & Spiers Machine Co., Waterbury, Conn., all of the drawings, patterns, etc., of the different lines of machinery and presses that the latter company has manufactured. In the future the Manville Brothers Co. will continue the manufacturing of these machines, and Mr. Cross will be connected with this concern as a special representative.

BETTENDORF AXLE CO., Bettendorf, Iowa, has gradually extended its plant in the past few years to accommodate its growing business. The new site at Bettendorf, a suburb of Davenport, covers an area of 70 acres. The main shop of the plant is a building 700 x 240 feet, and contains perhaps the most complete hydraulic plant in the country. All, or nearly all, of the shaping of the car parts is done on hydraulic presses, of which there are about sixty, varying in capacity from 50 to 1,800 tons pressure.

PETER HOOKER, LTD., Atherton's Quay, Warrington, England, has taken over from the receiver of the Newell Engineering Co., Ltd., the entire plant, stocks, patents, and good will of that company's business in limit gages, measuring machines, micrometers, surface-plates and other products. The business will be continued as a department at the Peter Hooker, Ltd., Works, Blackhouse Lane, Walthamstow, London. It is expected that the new factory will be equipped and in running order about December 1.

HESS-BRIGHT MFG. CO., Philadelphia, Pa., has sent us a translation from *La Technique Automobile* regarding Prof. Stribeck's investigations of ball bearings. Prof. Stribeck is the director of the laboratories of scientific and technical research at Neu Babelsberg, Ger-

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many, and his investigation was done at the instigation of the Deutsche Waffen und Munitionsfabriken of Berlin. The Hess-Bright ball bearings are a result of these investigations. It was demonstrated that the use of ball bearings is not necessarily restricted to light loads, but that they can be adapted to heavy service with advantage.

The officers and executive committee of the Southern Supply & Machinery Dealers' Association held a meeting in Louisville, Ky., September 21-22, at which resolutions were passed relative to the death of Mr. Charles H. Briggs of the Briggs-Weaver Machinery Co., and president of the association last year. Resolutions were passed re-endorsing the re-sale plan adopted by many manufacturers, and the manufacturers were requested to assist the membership as much as possible in helping to maintain these prices. It was the general opinion of the members present that trade conditions have very much improved. Alvin M. Smith of the Smith-Courtney Co., Richmond, Va., is secretary and treasurer.

Crocker-Wheeler Co., Ampere, N. J., has built a brick and cement post-office building on its grounds to facilitate the ever-increasing volume of mail at the Ampere post-office. The architecture is of a modern classical style which might be termed "federal." Upon the pediment above the main entrance is an eagle and U. S. shield in high relief. The interior of the building is finished in quartered oak and the floor is of mosaic tile. Upon the walls hang a fac-simile of the Declaration of Independence, with the coats of arms of the various States, Constitution of the United States and an autograph letter and portrait of A. M. Ampere (1775-1853), after whom Ampere is named, and whose name is also used throughout the world to designate the unit of electric current.

MISCELLANEOUS.